WHIP ANTENNA
LOCK BAND SELECTOR AND TUNING CONTROL BEFORE RELEASING FROM MANUAL
RESET
CHANNELS
FUSE 15 AMP 24 VOLT
DYNAMOTOR FUSES
INDICATOR
TRANSMITTER, RADIO T-195B/GRC19
STAND BY
CW
CALIBRATE
VOICE/FSK
OFF
SERVICE SELECTOR
NORMAL
DUPLEX
BATT
PA PATH
PA GRID
ST KEY
ON

Giovanni Gianni Becattini

Surplus photo-parade

A fragment of technology history: pictures and notes of the most-known military surplus radio and electronic equipment from 1940 to 1970

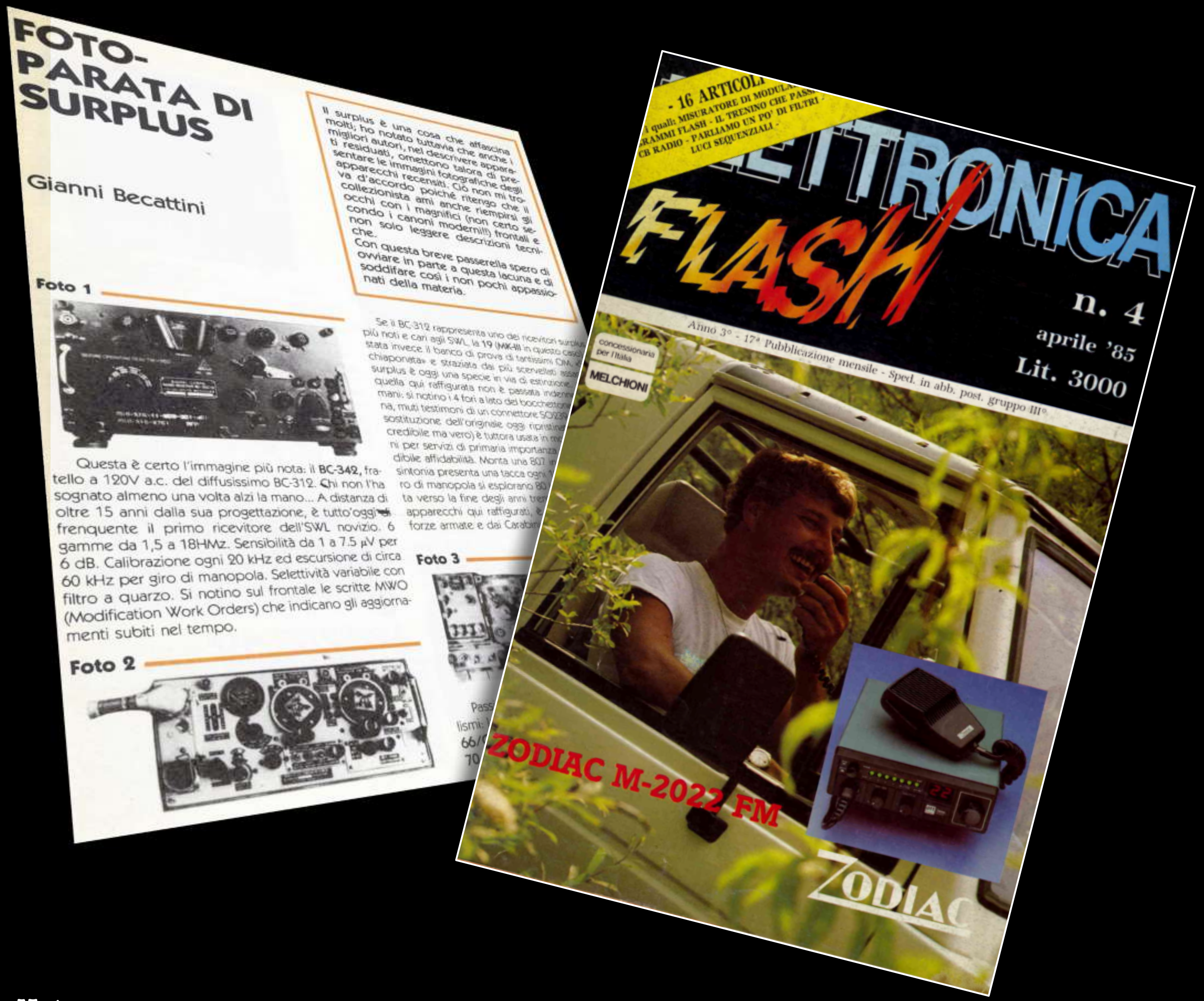


FOTO-PARATA DI SURPLUS

Gianni Becattini

Il surplus è una cosa che affascina molti; ho notato tuttavia che anche i migliori autori, nel descrivere apparati residuati, omettono talora di presentare le immagini fotografiche degli apparecchi recensiti. Ciò non mi trova d'accordo poiché ritengo che il collezionista ami anche riempirsi gli occhi con i magnifici (non certo secondo i canoni moderni!!) frontali e non solo leggere descrizioni tecniche.

Con questa breve passerella spero di ovviare in parte a questa lacuna e di soddifare così i non pochi appassionati della materia.

Foto 1

Questa è certo l'immagine più nota: il **BC-342**, fratello a 120V a.c. del diffusissimo BC-312. Chi non l'ha sognato almeno una volta alzi la mano... A distanza di oltre 15 anni dalla sua progettazione, è tutto'oggi frenquente il primo ricevitore dell'SWL novizio. 6 gamme da 1,5 a 18HMz. Sensibilità da 1 a 7.5 µV per 6 dB. Calibrazione ogni 20 kHz ed escursione di circa 60 kHz per giro di manopola. Selettività variabile con filtro a quarzo. Si notino sul frontale le scritte MWO (Modification Work Orders) che indicano gli aggiornamenti subiti nel tempo.

Foto 2

Se il BC-312 rappresenta uno dei ricevitori surplus
più noti e cari agli SWL, la **19** (MK-III in questo caso)
stata invece il banco di prova di tantissimi OM.
chiaponata» e straziata dai più scervellati
surplus è oggi una specie in via di estinzione
quella qui raffigurata non è passata inden
mani: si notino i 4 fori a lato del bocchetto
na, muti testimoni di un connettore SO239
sostituzione dell'originale oggi ripristina
credibile ma vero) è tuttora usata in
ni per servizi di primaria importanza
dibile affidabilità. Monta una 807
sintonia presenta una tacca ogni
ro di manopola si esplorano 80
ta verso la fine degli anni tre
apparecchi qui raffigurati,
forze armate e dai Carabin

Foto 3

- 16 ARTICOLI
i quali: MISURATORE DI MODULA
RAMMI FLASH - IL TRENINO CHE PASS
CB RADIO - PARLIAMO UN PO' DI FILTRI -
LUCI SEQUENZIALI -
ELETTRONICA FLASH
n. 4
aprile '85
Lit. 3000
Anno 3° - 17ª Pubblicazione mensile - Sped. in abb. post. gruppo III°
concessionaria per l'Italia
MELCHIONI
ZODIAC M-2022 FM
ZODIAC

Notes

This stuff is copyrighted (except for the parts I took from somebody else), but it's absolutely free, I wrote it just for amusement. You can copy, print and/or distribute it as you want and even sell if you are capable of, provided that you don't modify it.

I don't claim any historical rigor: I am not an expert, if I wrote something wrong or infringed somebody else's rights, write me and I will correct it.

Foreground

Electronic military surplus became important after the WW2, being the only way for many to get hold of equipment otherwise not available and/or very expensive. Today, it is a relevant part of our technological history.

In 1985, I wrote for Elettronica FLASH, an Italian magazine, an article named "Fotoparata di surplus" (Surplus photo-parade). I had observed that most of the articles about surplus were strictly technical, whilst I have been liking this type of equipment also for their look and feel.

I was then 34 and I had a number of surplus equipment, mostly from WW2. In the following years, for reasons beyond my control, I had to sell my beloved collection, but surplus remained in my heart for ever.

That magazine does not any longer exist, but the original article is still available online (http://www.introni.it/pdf/Elettronica%20Flash%201985_04.pdf). Its graphical quality was, however, originally non exceptional and today is definitely poor.

The wolf loses its fur but not its vice. So, after about 40 years, and a life dedicated to modern electronics, I started again collecting some pieces of surplus equipment and, again, I like to depict them with a minimum of graphics, with few notes for each of them.

I hope that these pages will be appreciated by others who, like me, love these witnesses of a distant era.

Giovanni Gianni Becattini

146
7D01F boards
147
A5 Interconnect board
A6 Power supply board
A3 Output board
A2 Memory board
A4 Cursor board
A4 Acquisition board
A3 Intelligence board
A2 Button light board
7904 OSCILLOSCOPE
ni Becattini
ktronix oscilloscope
o report about Tektronix 7000-Series oscilloscopes

Introduction to new editions

Edition 9

September 2022 - A larger space was dedicated to BC-221 frequency meter, that used to be, for a long time, the only professional instruments that many enthusiasts could afford. Furthermode, the description of two new equipment has been added (TS-375/U and TS-497/URR). Finally, the Tektronix section has been removed and separated in a new book "Tektronix oscilloscopes".

Edition 8

August 2022 - Further additions to the Tektronix section and mainly a technical note on the power supply section, with a large drawing of interconnections (a dedicated note on this topic can be freely downloaded by the Surplus Parade web page). See the revision history on page 170 for the revisions' exact details.

Edition 7

July 2022 - The Tektronix section has been rewritten and significantly extended, thanks to historical documents found on TekWiki.

Edition 6

July 2022 - The most important evolution is the addition of a ***new Tektronix section****, dedicated to one of the most important companies in history of the world, producing electronic instruments. I went with a friend to a fair, where I could find a lot of material, that, until then, I considered too expensive. So, I started a wonderful new way to lose my time, restoring the old oscilloscopes, that I strongly would have liked to own at the far time I was at the university. As a consequence, I moreover opened this booklet to the transistor technology.*

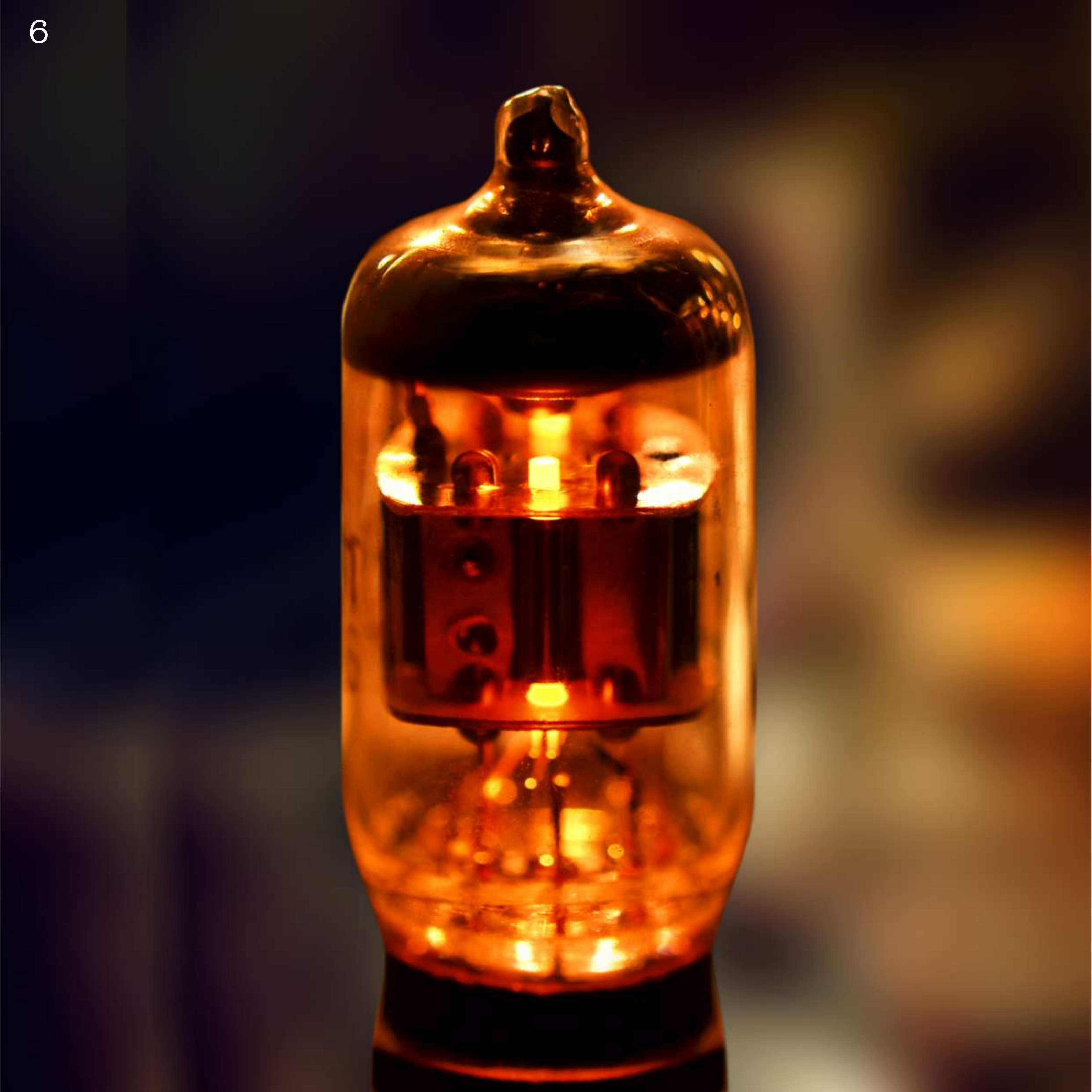
Another improvement is related to the German ***Siemens E311 receiver****, also purchased at the fair, on which I have been working hard to repair (there is* ***a dedicated document*** *describing this repair on the page where you downloaded this booklet, together with the* ***revised original manuals****). It is really an interesting receiver, for its tube-based, digital electronic-free, PLL tuning.*

Edition 5

I added various equipment and tried to give a better time collocation to each of them, applying a label with the presumed year of introduction and reordering the pages accordingly. I also added a timeline to easier understand time relationships among them and a table of content at the end of the document.

DOWNLOAD ME TOO, I AM FREE!

The section related to Tektronix oscilloscopes is no longer part of this document, and became a 174 pages separate book, with a large number of photos. You can download it for free from http://www.k100.biz/parade.htm



The magic of tubes

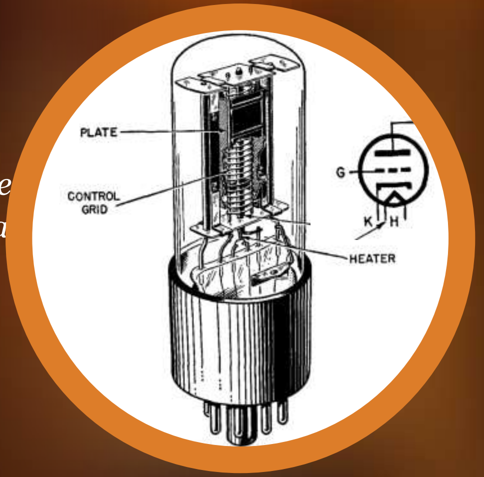
A vacuum tube (or valve, according to the British) is a device capable to control a flow of electrons by mean of an electric potential difference. Something, thus, capable of adjusting the flow of a current with a much lower current, like a tap controlling a flux of water, but at an incredible speed, such that can be used at the rhythm of the human voice or even much faster.

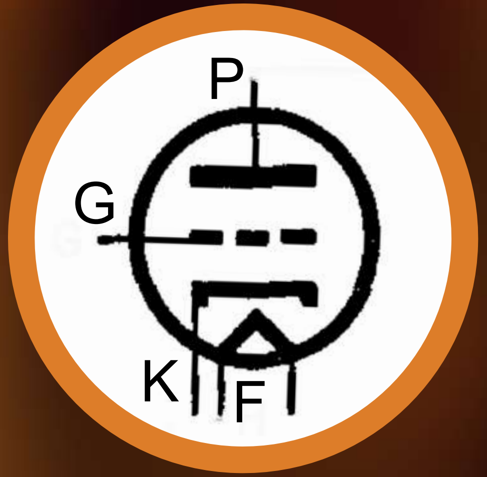
The tubes, invented in 1904 by John Ambrose Fleming, became a key component of electronic circuits for the first half of the twentieth century and changed forever the human life, allowing to the development of radio, television, radar, sound recording and reproduction, long-distance telephone networks, and analog and early digital computers until, in the sixties, they were gradually replaced by semiconductors. But that was mainly a ***technological*** *leap (i.e., replacing a technology with a new one), whilst the tubes were a* ***logic*** *leap, allowing things that before had been impossible.*

Most of our beloved surplus equipment uses these fascinating devices or, better, our beloved equipment has the only purpose to host the tubes and allow them to live happily and to perform their duties in the best way.

Tubes are much more energy hungry than transistors, but, with their weak glow and with their heat, were more human and similar to living things, like a steam locomotive in front of a high speed train.

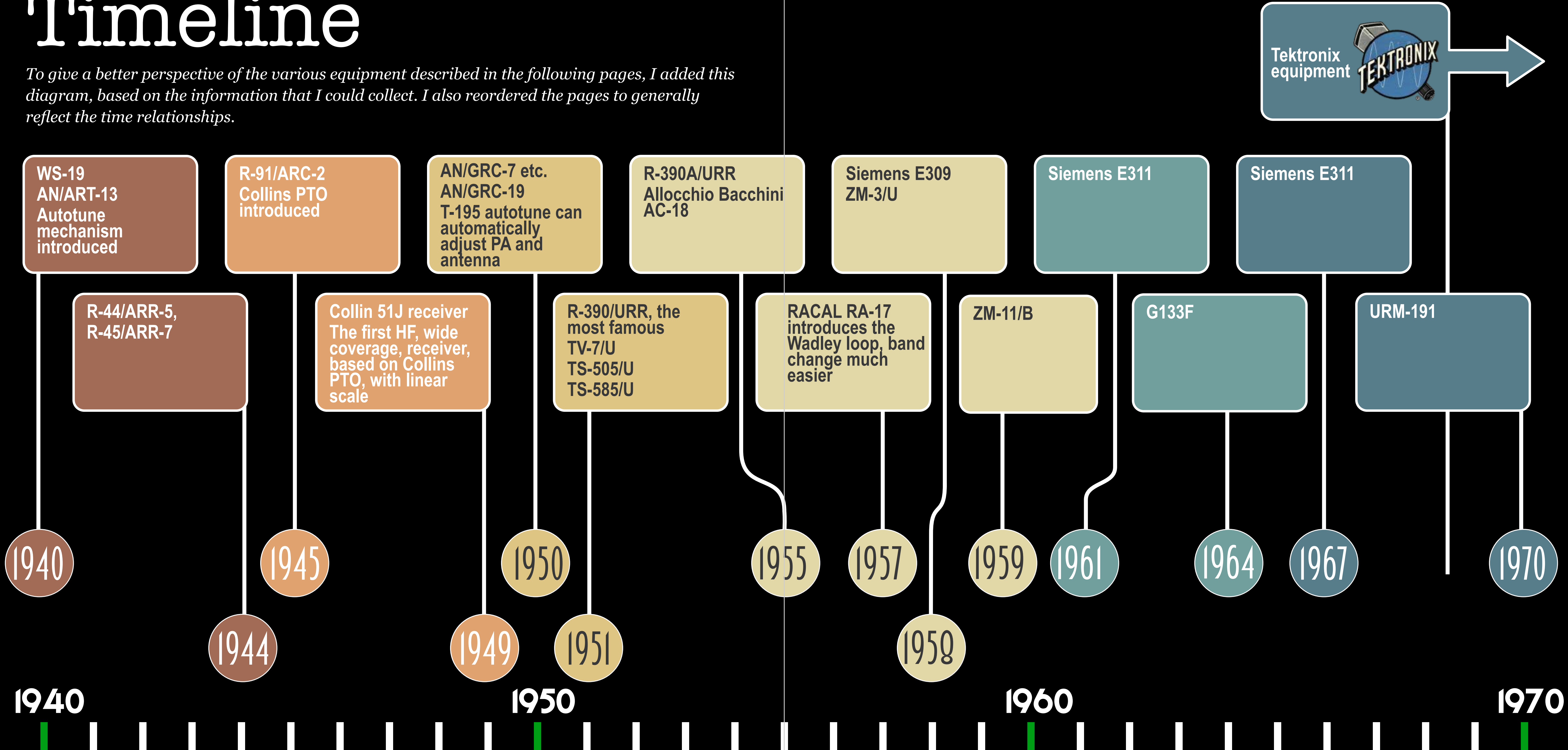
There are many kind of tubes and not all are “vacuum”. You will find lot of them in the following pages.





Timeline

To give a better perspective of the various equipment described in the following pages, I added this diagram, based on the information that I could collect. I also reordered the pages to generally reflect the time relationships.



Tektronix equipment

WS-19
AN/ART-13
Autotune mechanism introduced

R-91/ARC-2
Collins PTO introduced

AN/GRC-7 etc.
AN/GRC-19
T-195 autotune can automatically adjust PA and antenna

R-390A/URR
Allocchio Bacchini AC-18

Siemens E309
ZM-3/U

Siemens E311

Siemens E311

R-44/ARR-5,
R-45/ARR-7

Collin 51J receiver
The first HF, wide coverage, receiver, based on Collins PTO, with linear scale

R-390/URR, the most famous
TV-7/U
TS-505/U
TS-585/U

RACAL RA-17 introduces the Wadley loop, band change much easier

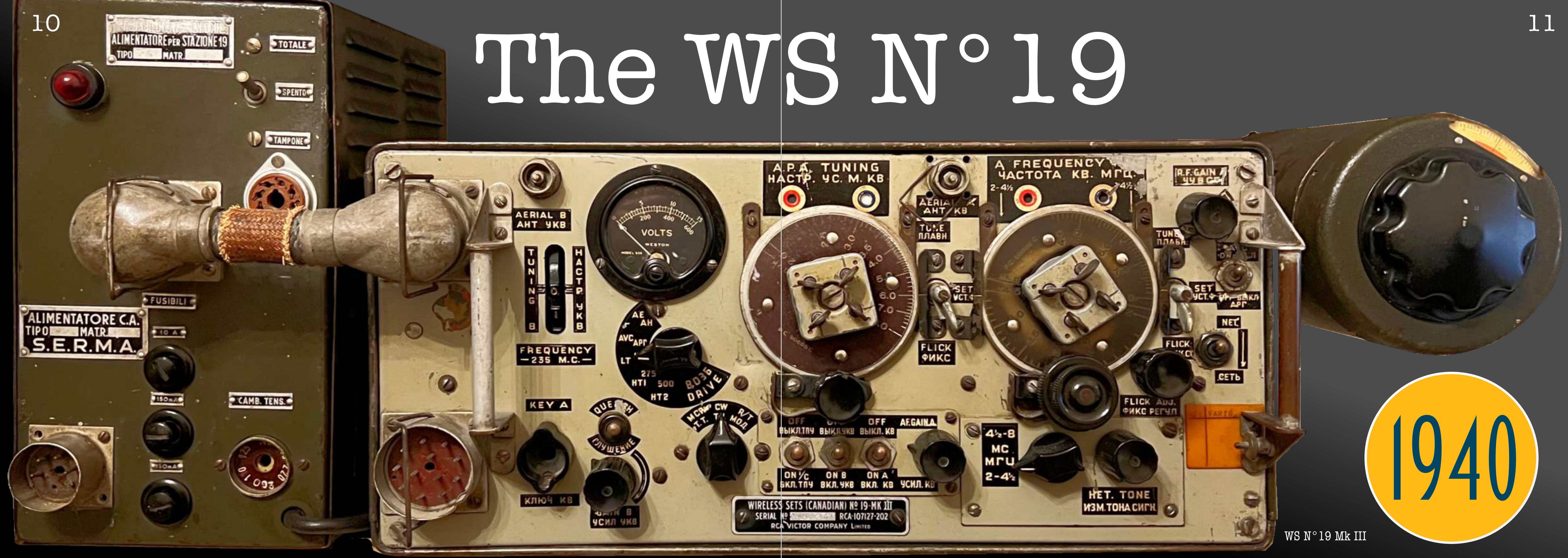
ZM-11/B

G133F

URM-191

1940
1944
1945
1949
1950
1951
1955
1957
1958
1959
1961
1964
1967
1970
1940
1950
1960
1970

The WS N°19


ALIMENTATORE PER STAZIONE 19
TIPO
MATR.
TOTALE
SPENTO
TAMPONE
FUSIBILI
ALIMENTATORE C.A.
TIPO
MATR.
S.E.R.M.A.
10 A
150mA
350mA
CAMB. TENS.
AERIAL B
АНТ УКВ
TUNING B
НАСТР УКВ
FREQUENCY
—235 M.C.—
VOLTS
WESTON
KEY A
КЛЮЧ КВ
QUENCH
ГЛУШЕНИЕ
GAIN B
УСИЛ УКВ
AE АН
AVC АРУ
LT
HT1
HT2
275
500
BOOST DRIVE
MCW
CW
R/T
A.P.A. TUNING
НАСТР. ЧС. М. КВ
AERIAL A
АНТ КВ
TUNE
ПЛАВН
SET
УСТ.Ч
FLICK
ФИКС
OFF
ВЫКЛ.ТПУ
ВЫКЛ.УКВ
ВЫКЛ. КВ
AF.GAIN A
ON I/C
ВКЛ.ТПУ
ON B
ВКЛ.УКВ
ON A
ВКЛ. КВ
УСИЛ. КВ
A FREQUENCY
ЧАСТОТА КВ. МГЦ.
2-4½
4½-8
MC
МГЦ
R.F.GAIN A
NET
СЕТЬ
FLICK ADJ.
ФИКС РЕГУЛ
HET. TONE
ИЗМ.ТОНА СИГН.
WIRELESS SETS (CANADIAN) No 19-MK III
SERIAL No
RCA-107127-202
RCA VICTOR COMPANY LIMITED

1940

WS N°19 Mk III

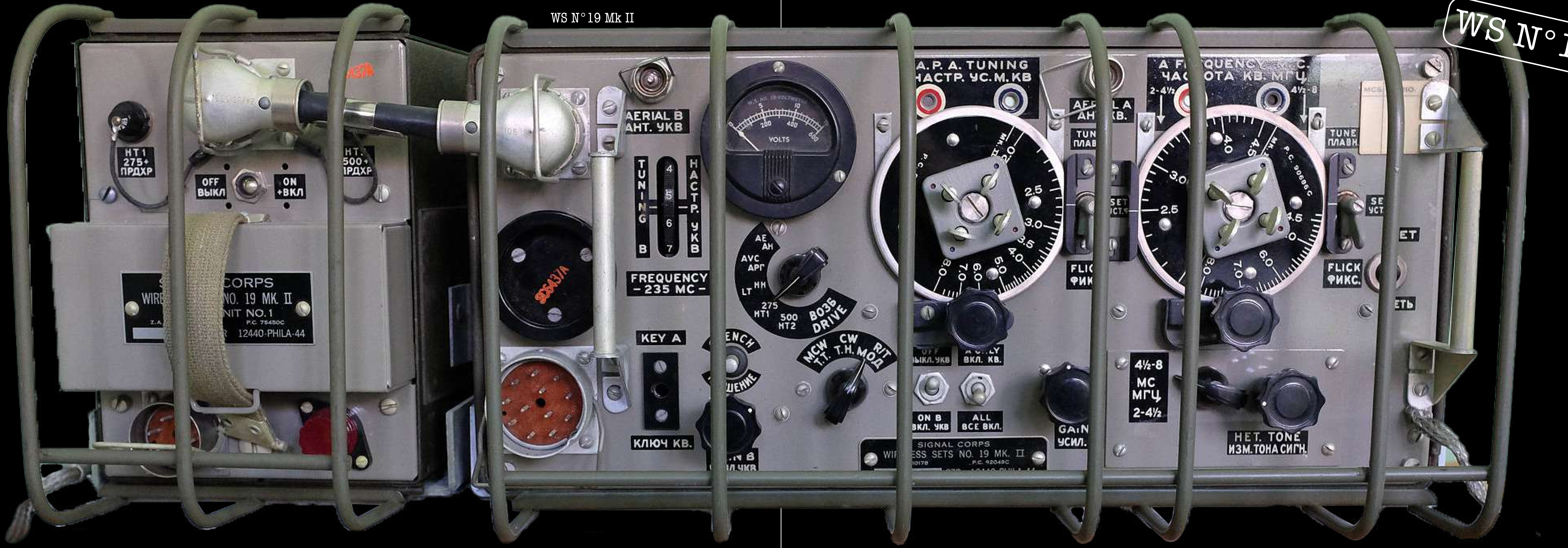
She was my first love. In 1965 I received as a gift a copy of an Italian magazine, where I found the advertisement of a "19" unit, with slyly boosted specifications: 50W RF was the only parameter I could understand and, even if fake, was enough for me.

But with no money, it remained a dream. In 1966, in Florence we got a big flood. Art treasures were submerged, but in my student mind, happy because the school had been destroyed, the 19 was still in my dreams. The 19 was still in use by Carabinieri (Italian police corp), which, after the war, couldn't afford anything more expensive. A friend of mine, a Carabinieri official's son, told me: "if you like, they are discarding their drown 19s. If you want, you can get one for free". In few minutes I was there and got MY first beloved 19.

The problem was then: how can I carry it home? I was not very strong but I had no doubts. I picked it up and carried it by hands. Few meters and stop. Few meters and stop. It took about 3 hours to get home this way. But at end, when I arrived, I found there a Carabinieri jeep waiting for me. "Sorry boy, we need to take it back. It must be officially destroyed in Rome". I had so to wait until 1979, when I could buy one, and she remained with me until today. When I had to sell my surplus collection, I couldn't say her good-by, and you can see her in these pages.

The power supply in the photo was built by Italian army to use the 19 as a fixed station, instead of the original dynamotor, designed for vehicles.

WS N°19 Mk II

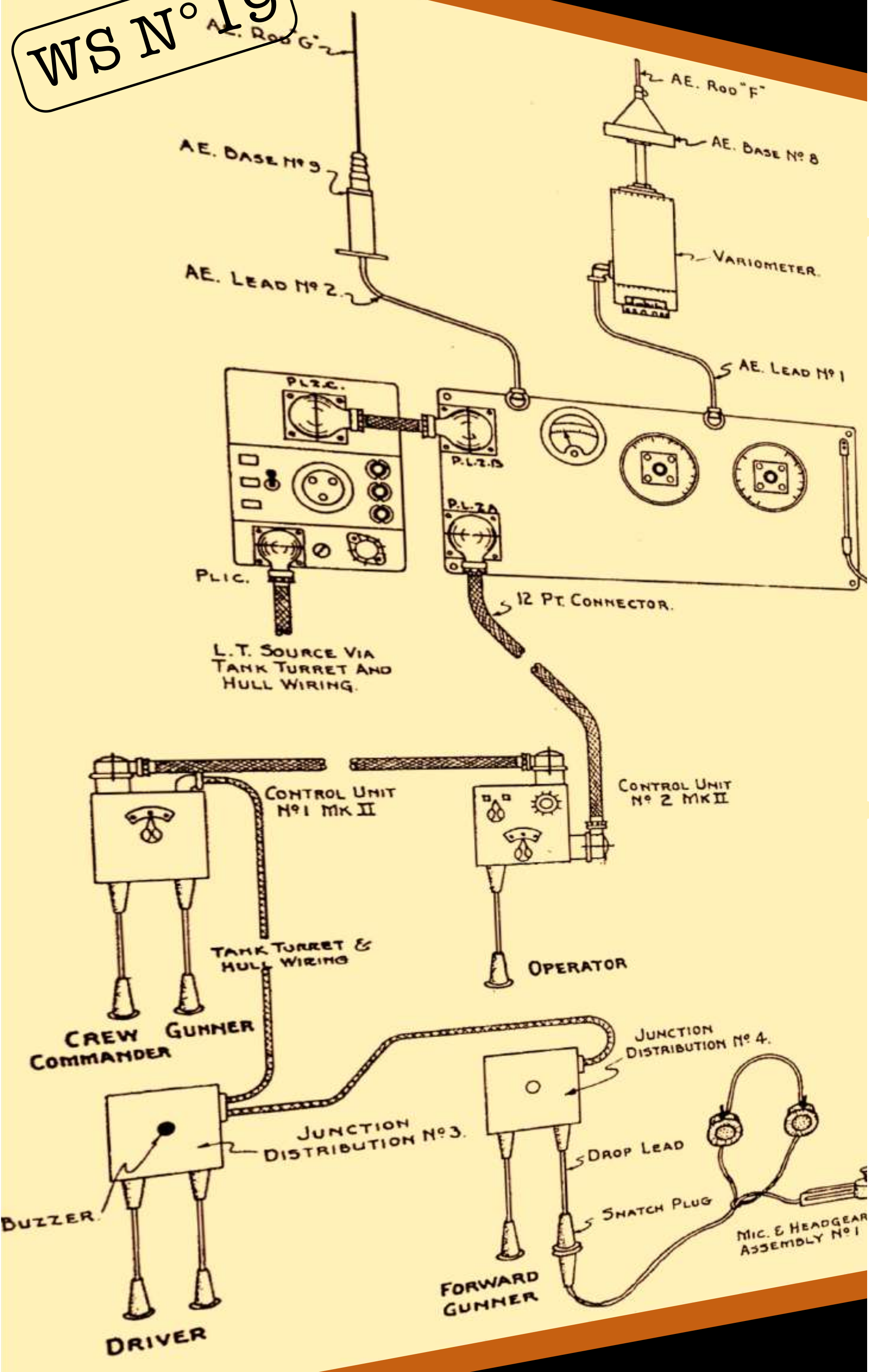

HT 1 275+ ПРДХР
OFF ВЫКЛ
ON +ВКЛ
HT 500+ ПРДХР
CORPS
WIRE NO. 19 MK. II
NIT NO.1
P.C. 75450C
12440-PHILA-44
AERIAL B АНТ. УКВ
TUNING B
НАСТР. УКВ
VOLTS
FREQUENCY – 235 MC –
AE AH
AVC АРГ
HH
LT
275 HT1
500 HT2
ВОЗБ DRIVE
KEY A
КЛЮЧ КВ.
MCW CW R/T
T.T. T.H. МОД
A.P.A. TUNING НАСТР. УС.М.КВ
AERIAL A АН КВ.
TUNE ПЛАВН.
SET УСТ.
FLICK ФИКС.
A FREQUENCY M.C. ЧАСТОТА КВ. МГЦ
2-4½
4½-8
ON B ВКЛ. УКВ
ALL ВСЕ ВКЛ.
GAIN УСИЛ.
4½-8 MC МГЦ 2-4½
HET. TONE ИЗМ.ТОНА СИГН.
SIGNAL CORPS
WIRELESS SETS NO. 19 MK. II

Wireless Sets No. 19 was a mobile transmitter-receiver designed by Pye Ltd in Cambridge to provide radio communications for Armoured Fighting Vehicles (AFV) in the British Army. The design was quickly adapted for use in a wide range of other vehicles; trucks, jeeps, ground stations and even aircraft. Thanks to its versatility, various versions of the 19 were also used by Australian, Canadian, Italian and Russian forces, and the equipment was manufactured in the UK, Australia, USA and Canada. Introduced in 1940, remained in service until 1960. Two modified versions were introduced, Mk. II in 1941 (here above) and Mk. III in 1942 (mine, in the previous photo on page 10).

Originally, the 19 used a separate dynamotor power supply unit (photo above) A separate aerial tuning unit , said variometer and shown on page 7, was used to match the transmitter output to the 12-foot aerial rod mounted on the turret or roof of the vehicle. The 19 has been widely use in Italy after the war, for the army, the police, the Carabinieri, and many other services, as a fixed station, with a mains AC power supply, built by local firms (page 7).

Surplus merchants in Italy had lot of them and in some periods you could buy one for few thousand liras (as low as 25$). Today it is not easy to find one. The few units still available are priced around 400-500 euro, when in good state. I eat my hands thinking that I kept only one…

Note: the photo above is not from me, I took it from Wikipedia and it tells me that somewhere in this planet some lucky guy has this wonderful unit, still absolutely new (the photo is due to Autopilot - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=39679782). It is too beautiful not to add it to this document, thanks!


AE. ROD "G"
AE. ROD "F"
AE. BASE No 9
AE. BASE No 8
VARIOMETER
AE. LEAD No 2
AE. LEAD No 1
PL2C
PL2B
PL2A
PLIC
12 PT. CONNECTOR
L.T. SOURCE VIA TANK TURRET AND HULL WIRING
CONTROL UNIT No 1 MK II
CONTROL UNIT No 2 MK II
TANK TURRET & HULL WIRING
OPERATOR
CREW COMMANDER
GUNNER
JUNCTION DISTRIBUTION No 4
JUNCTION DISTRIBUTION No 3
DROP LEAD
SNATCH PLUG
MIC. & HEADGEAR ASSEMBLY No 1
BUZZER
FORWARD GUNNER
DRIVER

Antenna connector

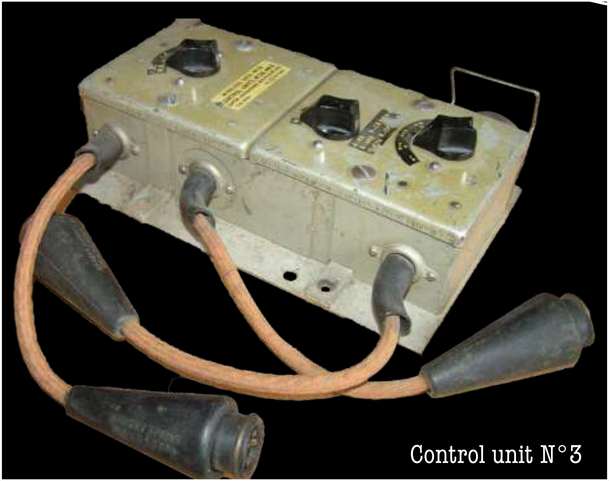
Control unit N°1

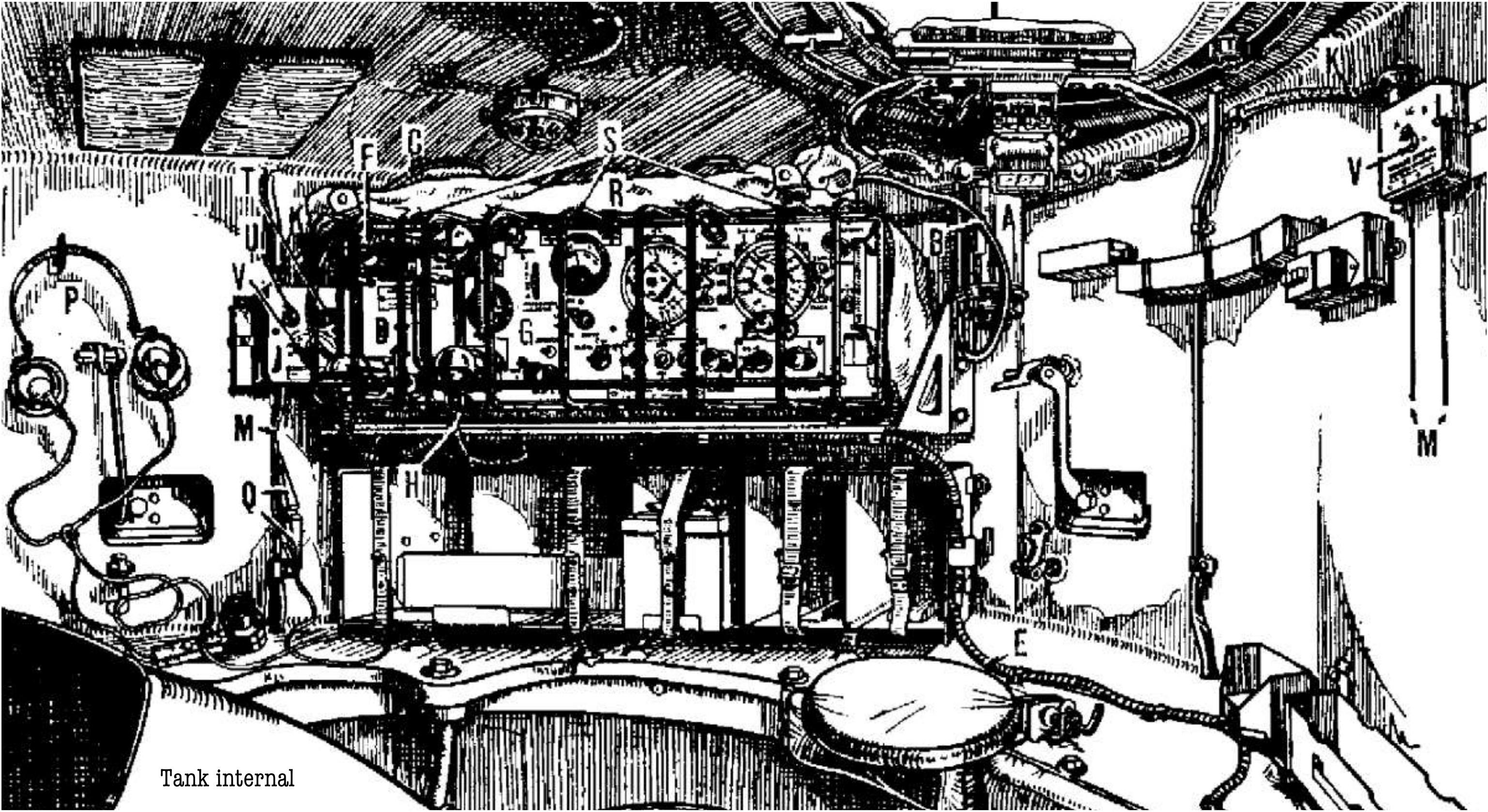
Control unit N°2

The 19 “system”

*The 19 was really composed by three different sets: **set A**, an RTX from 2.5 to 6.25 MHz, for longer range communications within the squadron or regiment; **set B**, at 235 MHz, to talk with troop around the tank, and **set C**, the “IC amplifier”, among all members of the crew of the vehicle, typically a tank.*

More than a piece of equipment, the 19 was so“a system”: more different components, that could be mixed together to equip the vehicle in the best way (diagram on the left). In this page, you can see some of the available accessories. I had some of them, but they were stolen from me in 1986. Luckily, the 19 itself was perhaps too heavy for the thieves.


Control unit N°3


T
U
V
P
M
Q
F
G
S
R
D
G
H
B
A
K
V
M
E
Tank internal

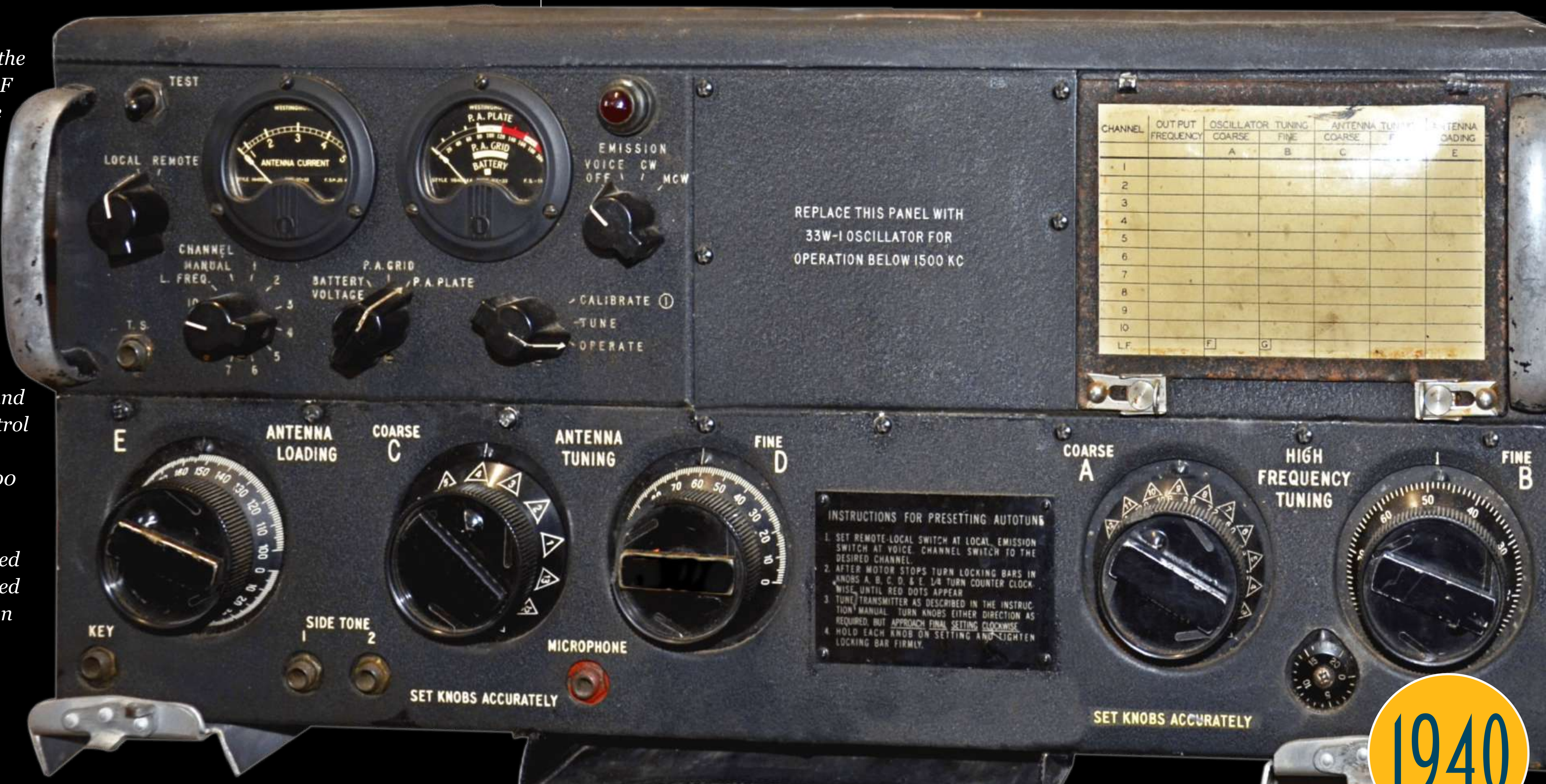
AN/ART-13 transmitter

During WW2, in 1940, the Collins Radio Company designed this radio transmitter for the US Navy and was used on many larger USAAF aircraft beginning late in World War II. Some were still in service in the early 1970s. Even the Enola Gay, the B-29 Super-fortress bomber that dropped "Little Boy", the first atomic bomb on Hiroshima, was equipped a transmitter like this.

The AN/ART-13 operated in CW (code), MCW and AM (voice) modes and covered LF, MF and HF frequencies up to 18.1 MHz. It had ten auto-tuned VFO tuned channels that could be preset. Post-war modifications and other companies added crystal frequency control capability and were approved for use on civil airliners. Power output was approximately 100 watts using an 813 vacuum tube as the final amplifier. Under favourable atmospheric conditions communications could be established between aircraft and ground stations separated by thousands of miles (most of this information was extracted from Wikipedia).

Very interesting the ***autotune mechanism****, about which we talk more extensively with ARC-2/RT-91 receiver/transmitter and T-195 transmitter.*

I don't own any longer this wonderful transmitter that I had in my previous surplus-life. Today, having not one of them, I got this photo from the Internet and I thank Al, W1VTP, for having kindly granted me to use it. See also http://amfone.net/Amforum/index.php?topic=43799.0


TEST
LOCAL REMOTE
ANTENNA CURRENT
P.A. PLATE
P.A. GRID
BATTERY
EMISSION
VOICE CW
OFF MCW
CHANNEL
MANUAL
L. FREQ.
BATTERY VOLTAGE
P.A. GRID
P.A. PLATE
CALIBRATE
TUNE
OPERATE
T. S.
REPLACE THIS PANEL WITH
33W-1 OSCILLATOR FOR
OPERATION BELOW 1500 KC
CHANNEL
OUTPUT FREQUENCY
OSCILLATOR TUNING
COARSE
FINE
ANTENNA TUNING
COARSE
ANTENNA LOADING
E
ANTENNA LOADING
COARSE C
ANTENNA TUNING
FINE D
COARSE A
HIGH FREQUENCY TUNING
FINE B
KEY
SIDE TONE
1 2
MICROPHONE
SET KNOBS ACCURATELY
INSTRUCTIONS FOR PRESETTING AUTOTUNE
1. SET REMOTE-LOCAL SWITCH AT LOCAL. EMISSION SWITCH AT VOICE. CHANNEL SWITCH TO THE DESIRED CHANNEL.
2. AFTER MOTOR STOPS TURN LOCKING BARS IN KNOBS A, B, C, D, & E 1/4 TURN COUNTER CLOCKWISE UNTIL RED DOTS APPEAR
3. TUNE TRANSMITTER AS DESCRIBED IN THE INSTRUCTION MANUAL. TURN KNOBS EITHER DIRECTION AS REQUIRED, BUT APPROACH FINAL SETTING CLOCKWISE
4. HOLD EACH KNOB ON SETTING AND TIGHTEN LOCKING BAR FIRMLY.
SET KNOBS ACCURATELY

1940

1940

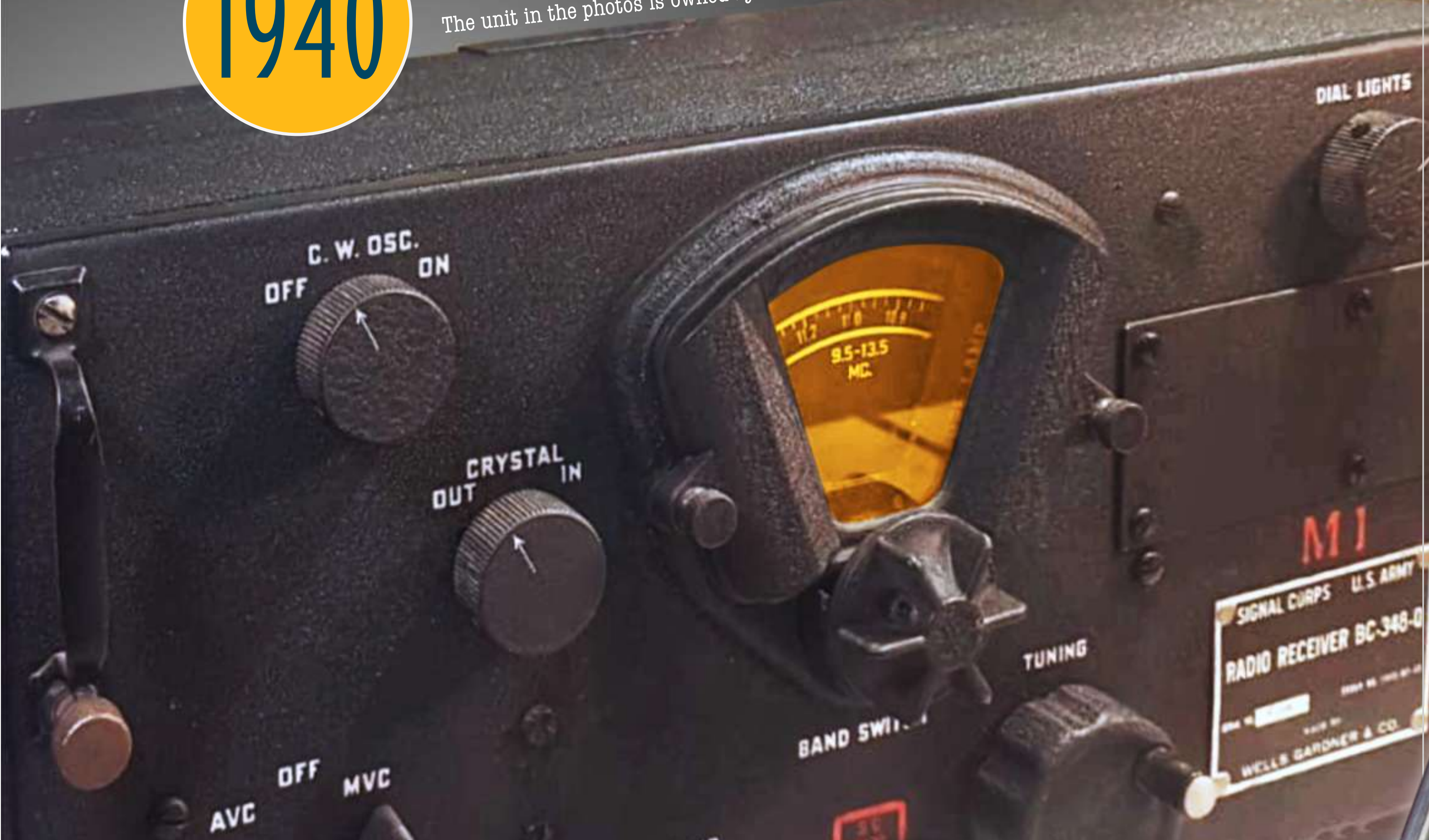
The unit in the photos is owned by Francesco Sartorello. Thanks!

BC-348 receiver

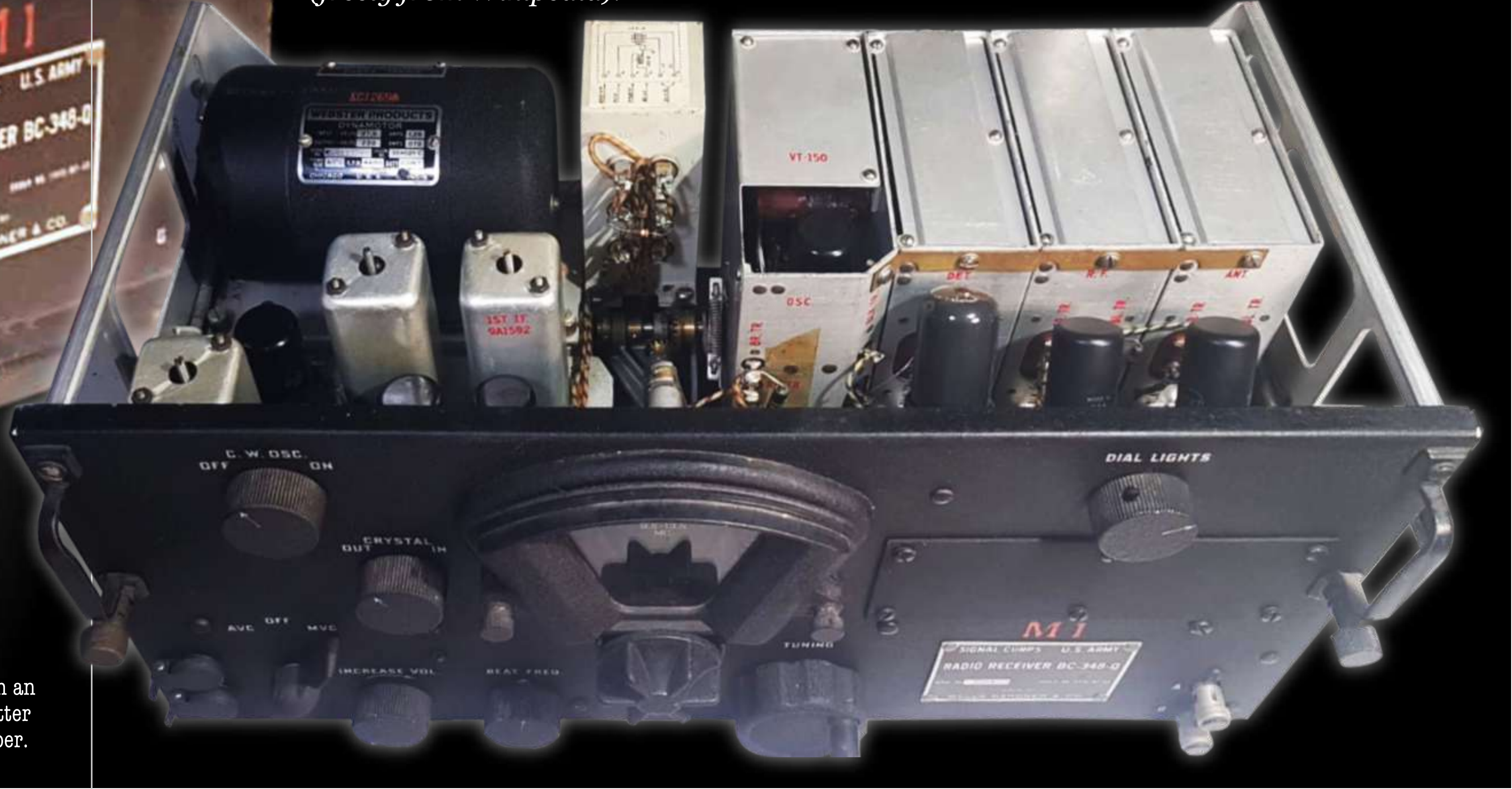
Judging from what you can read on the Internet, the BC-348 is one of the most beloved surplus receivers. It was the 28 Vdc version of the 1936 14 Vdc BC-224. Already then, the US technology was far beyond the rest of the world. Easy to operate and reliable, it was installed in almost all American and British multi-engined transports and bombers, until the Korean War. Designed as LF/MF/HF receivers for larger aircrafts (B-17, B-24, B-25, B-26, B-29, C-47, etc.), it was first paired with a BC-375 transmitter and then with the AN/ART-13, and was also used in some ground and mobile installations. More than 100,000 of them were produced, 80 percent by Belmont Radio and Wells-Gardner and the balance by RCA and Stromberg-Carlson.

BC-348 receivers were copied and manufactured by the USSR following WW2, through the 1970s, with such improvements as a solid state inverter to replace the dynamotor.

Enola Gay, the B-29 that dropped the Hiroshima bomb, was equipped with a BC-348 (freely from Wikipedia).


DIAL LIGHTS
C. W. OSC.
OFF
ON
9.5-13.5 MC
CRYSTAL
OUT
IN
TUNING
M I
SIGNAL CORPS U.S. ARMY
RADIO RECEIVER BC-348-Q
WELLS GARDNER & CO.
BAND SWI
AVC
OFF
MVC
BEAT FREQ.
INCREASE VOL.

BC-348 receiver with an AN/ART-13 transmitter on a Lancaster bomber.


WEBSTER PRODUCTS
DYNAMOTOR
VT-150
OSC
C. W. OSC.
OFF
ON
CRYSTAL
OUT
IN
DIAL LIGHTS
AVC
OFF
MVC
INCREASE VOL.
BEAT FREQ.
TUNING
M I
SIGNAL CORPS U.S. ARMY
RADIO RECEIVER BC-348-Q

R-44/ARR-5 receiver

1944

These are airborne search receivers intended to locate enemy radar radio frequency channels and communications equipment. Radio Receiving Set AN/ARR-5 operates in the frequency range 27.8 to 143 megacycles in 3 bands, whilst AN/ARR-45/ARR-7 works in the range 0.55 to 42 megacycles in 6 bands.

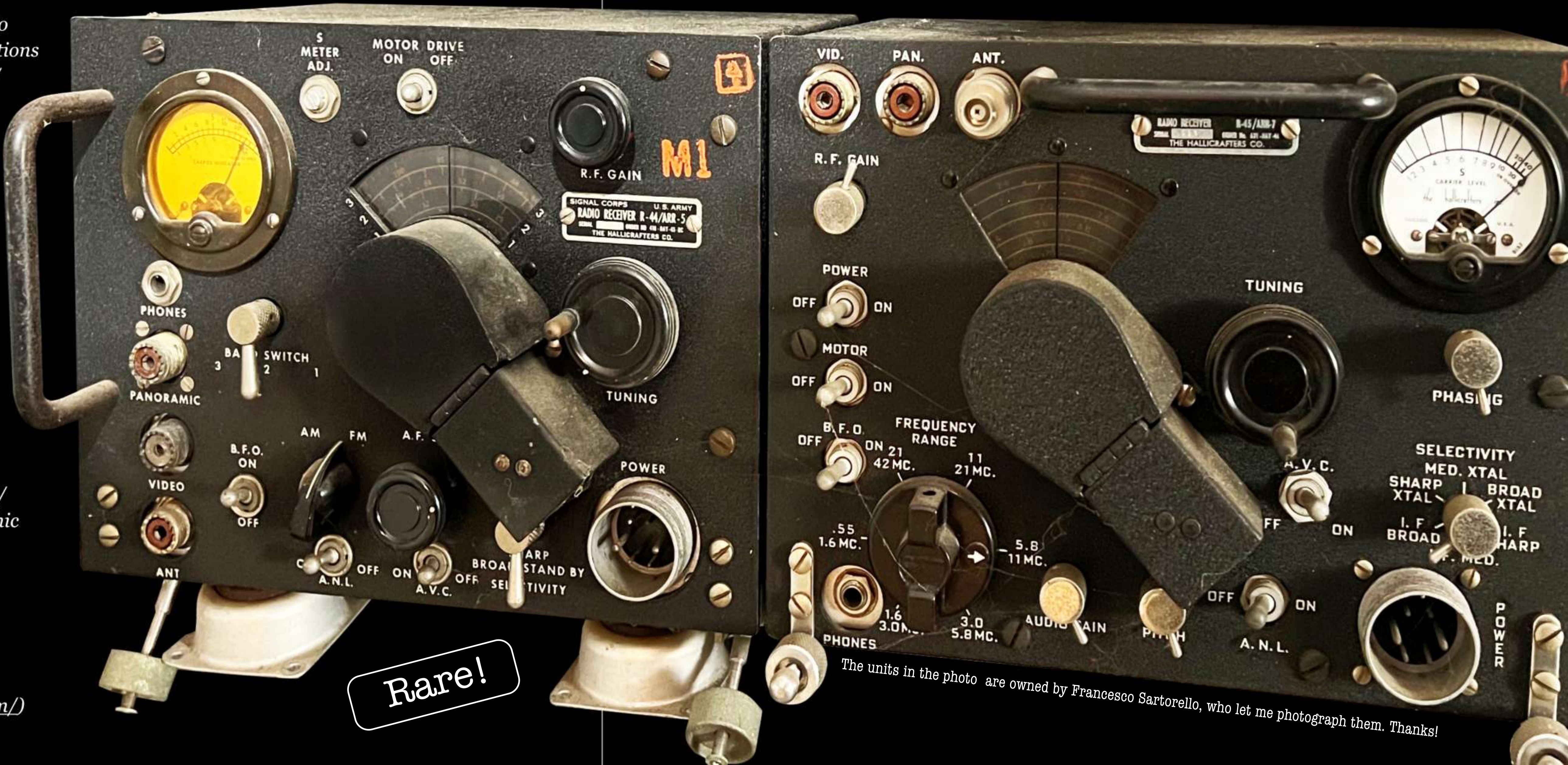
These receivers are designed to be used with equipment which will indicate visually and aurally the presence and character of received signals, over a pre-determined sector of a given tuning band.

It may be operated with Radar Indicator Assembly AN/APA-6 or AN/APA-11, Panoramic Adapter AN/APA-10 or BC-1050, and Photographic Adapter AN/APA-7.

They can receive either amplitude modulated or frequency modulated telephone signals and unmodulated continuous wave (CW) code signals.

(from http://www.radiomilitari.com/)

R-45/ARR-7 receiver


Rare!
S METER ADJ.
MOTOR DRIVE ON OFF
R.F. GAIN
M1
SIGNAL CORPS U.S. ARMY RADIO RECEIVER R-44/ARR-5
THE HALLICRAFTERS CO.
PHONES
PANORAMIC
VIDEO
ANT
BAND SWITCH 3 2 1
TUNING
B.F.O. ON OFF
AM FM A.F.
POWER
A.N.L.
A.V.C.
BROAD SHARP STAND BY SELECTIVITY
VID. PAN. ANT.
RADIO RECEIVER R-45/ARR-7
THE HALLICRAFTERS CO.
R.F. GAIN
POWER OFF ON
MOTOR OFF ON
B.F.O. OFF ON
FREQUENCY RANGE
21 42 MC.
11 21 MC.
.55 1.6 MC.
5.8 11 MC.
1.6 3.0 MC.
3.0 5.8 MC.
PHONES
AUDIO GAIN
PITCH
TUNING
PHASING
A.V.C.
SELECTIVITY
MED. XTAL
SHARP XTAL
BROAD XTAL
I. F. BROAD
I. F. SHARP
I. F. MED.
OFF ON
A. N. L.
POWER

The units in the photo are owned by Francesco Sartorello, who let me photograph them. Thanks!

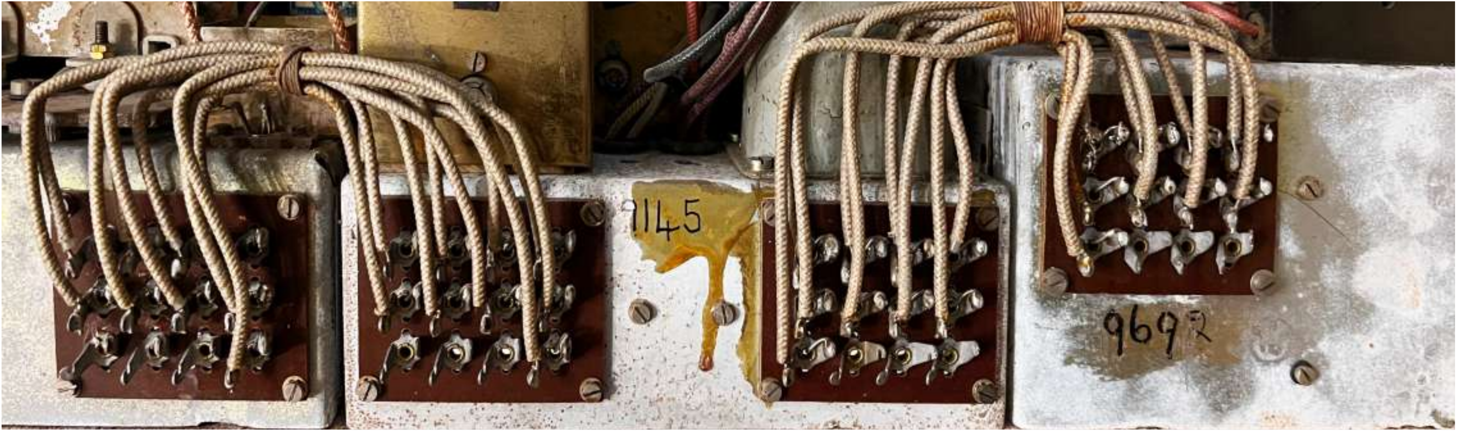
R-107 receiver The sensible ugly

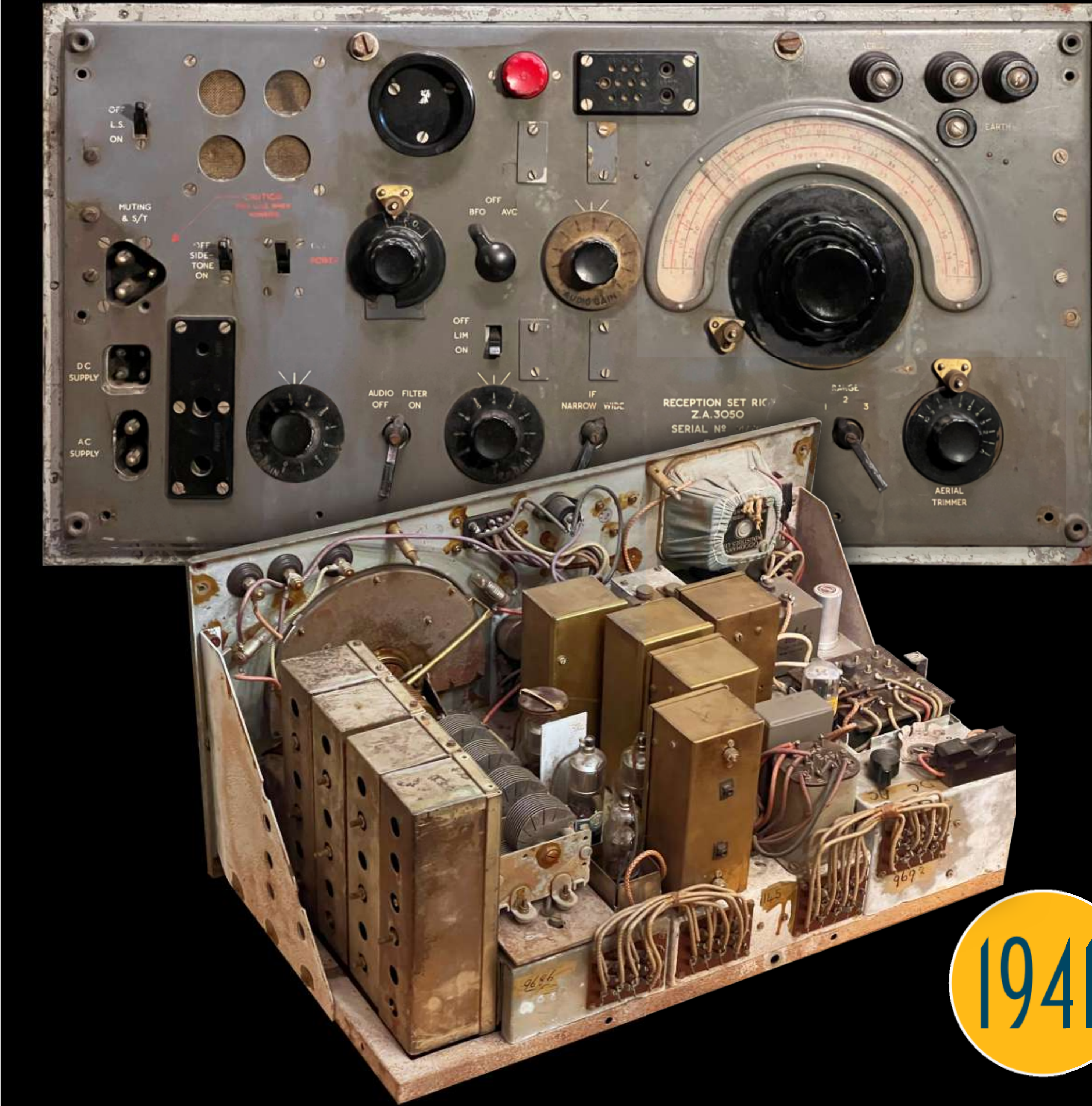
In 1966, my father bought me an unit like this, that was my first professional receiver. It was the cheapest equipment of this type (was payed 35,000 liras, 56 dollars with the exchange rate at the time), but for me it was exceptional and much more than expected. Really, it was not so wonderful: the frequency indication was just a vague figure and it had the stability of a ball in ship during a storm. However, it allowed me to start my SWL activity, not very successful indeed, because then, like today, I preferred eventually to play with electronics instead of using the equipment.

Someone places this receiver in 1940, whilst the manual reports April, 1941. Looking at it, even considering the technological gap between UK and USA, it seems based on a project from the thirties, as you can see from the photos. Only the sensitivity was good, with 1uV for 20dB S/N ratio (CW), but, in front of a 1940 BC-348, it literally disappears.

Interesting the attempt toward a modular construction, but the modules were linked by many soldered wires, that made hard to dismount them (photo below). Perhaps, the intention was more to have clearer boundaries between modules, to make easier the maintenance, than giving the possibility to replace modules. Interesting also the board with test points on the from panel.

Today this receiver is perhaps overestimated: on eBay you can find it at 600...800 euros. My unit is not in great conditions and I am not sure that I am going to restore it, also for the quality of the components, not very good: most of them need replacement.




OFF
L.S.
ON
MUTING & S/T
OFF
BFO
AVC
AUDIO GAIN
EARTH
OFF
SIDE-TONE
ON
OFF
LIM
ON
DC SUPPLY
AC SUPPLY
AUDIO FILTER
OFF ON
IF
NARROW WIDE
RECEPTION SET R107
Z.A.3050
SERIAL Nº
RANGE
1 2 3
AERIAL TRIMMER

1941

R-91/ARC-2

These receivers/transmitters are not very known and I don't own one of them, but I felt compelled to add these two new pages, because I realised I made a mistake in the previous edition, when I hinted that the 51J was the first Collins project based on PTO technology.

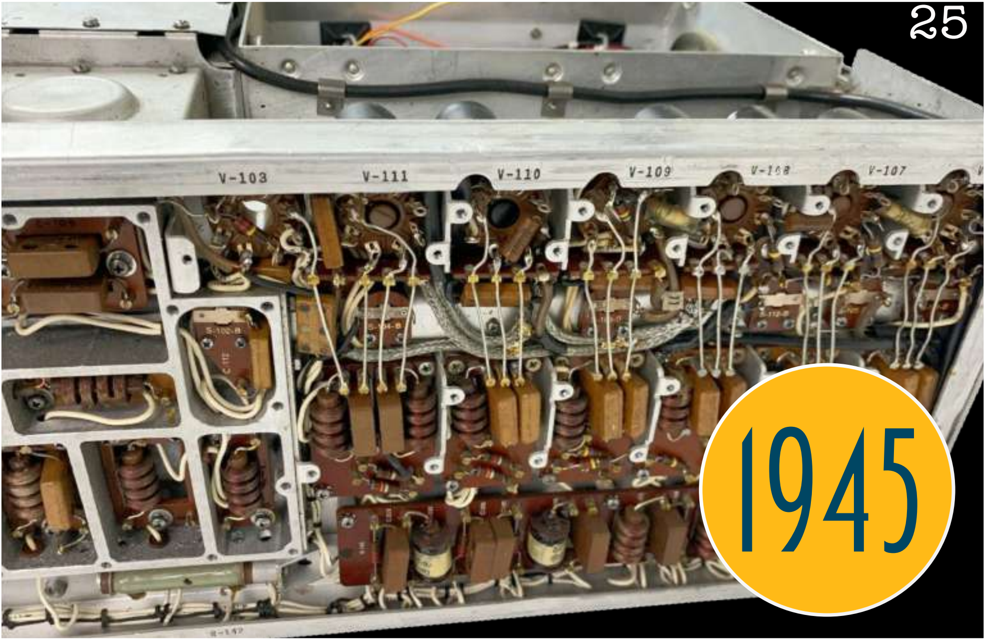
As I mentioned, ARC-2 was the first model where a Collins PTO has been used. The Permeability Tuned Oscillator was a big improvement in the technology of that time. Substantially, it was simply a variable oscillator, covering a precise frequency range (typically one MHz), in a few revolutions of an axis (typically ten), with an almost perfect linearity, making so possible to precisely tune a desired frequency, with an excellent stability. The ARC-2's PTO will be the base of other successful, shortly described in the following pages, such as 51J4, R-390 and R-390A/URR, R-392/URR and T-195/GRC-19.

But PTO was not the only innovative solution of ARC-2, destined to be widely reused in the subsequent projects. We are talking about the autotune system, first introduced, I believe in 1940 AN/ART-13.

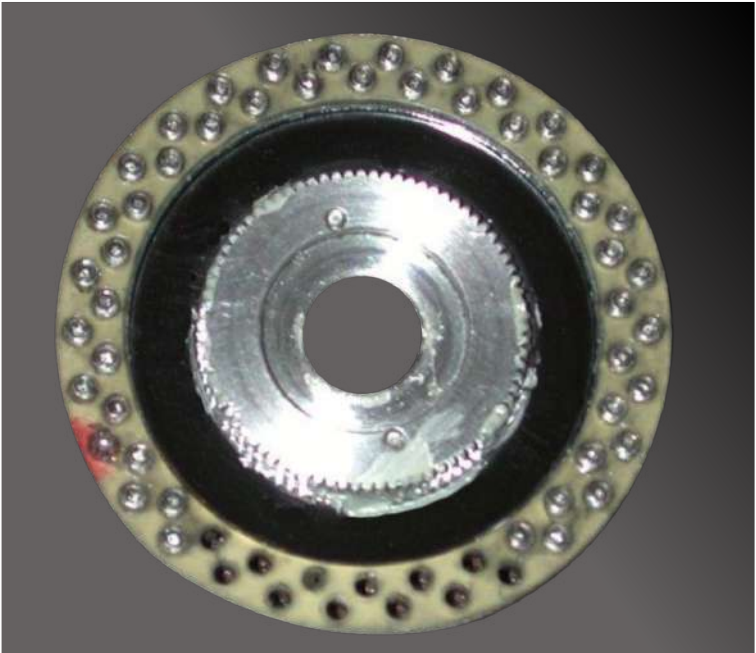
The autotune system is an electrically controlled means of mechanically repositioning adjustable elements such as switches, and variable inductors to predetermine settings. The system employed in this equipment consist of a motor, two single-turn mechanisms, two multi-turn mechanisms, a control mechanism, a line shaft several drive gears, and control circuit (from www.radiomilitari.com).

The autotune system will reach its top with the T-195 transmitter, with the effective capability to autotune the PA and the antenna, not only to memorise some preset positions.

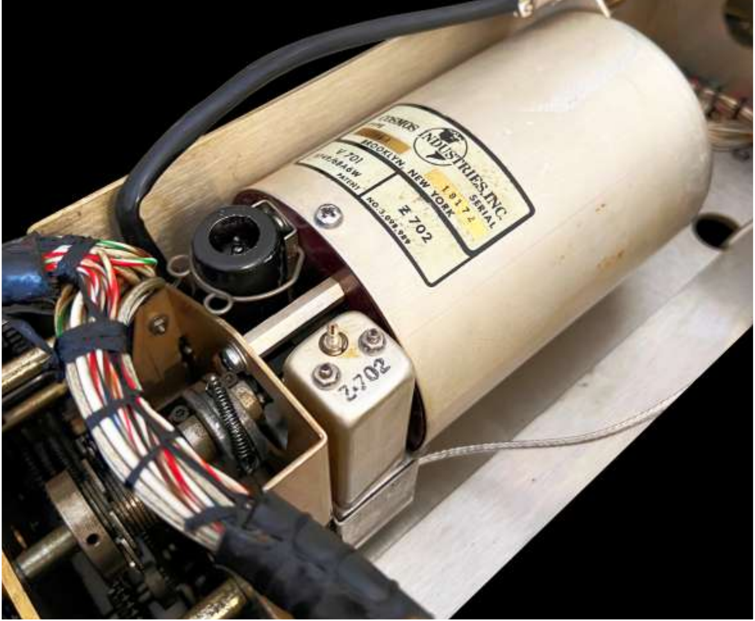
*By the way, I had no good picture of ARC-2 and could only get some in an eBay advertisement (I wrote to the seller to ask the permission, but had no reply. I hope he don't mind my little theft...). In this search, I ran across the very good site **www.radiomilitari.com**, where you can find the description and some photos of this rare and valuable unit, together with a lot of other information (thanks, Antonio!).*



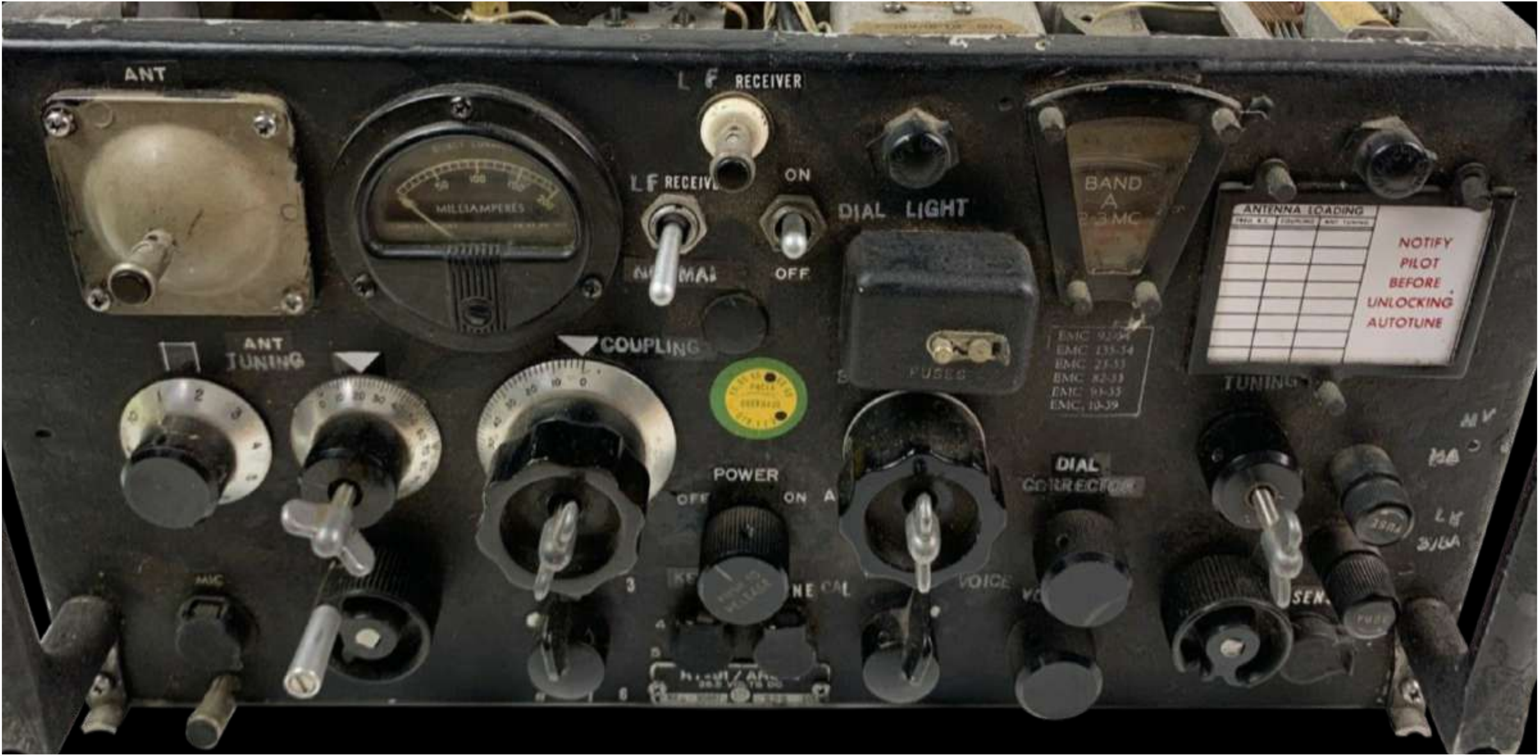
1945



To achieve the required linearity level, a disk with 48 micro-screw allow to correct the frequency in 48 points of the frequency range. The alignment requires experience and some special tool.



This is the main PTO of my R-390A, a more recent 136-1 type. Every 390 has two PTO, the second one is used for the BFO.



Collins 51J receivers

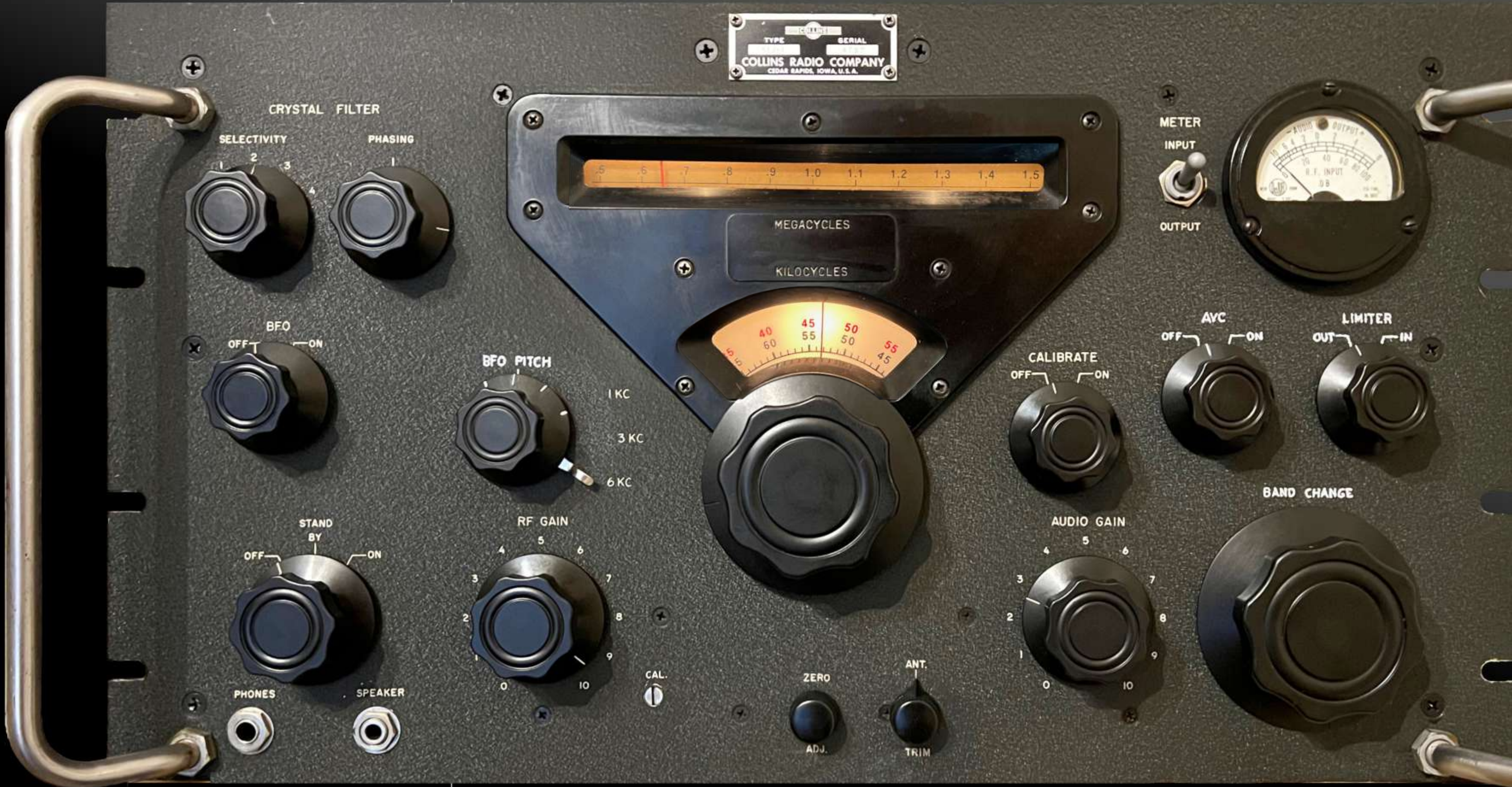
1949

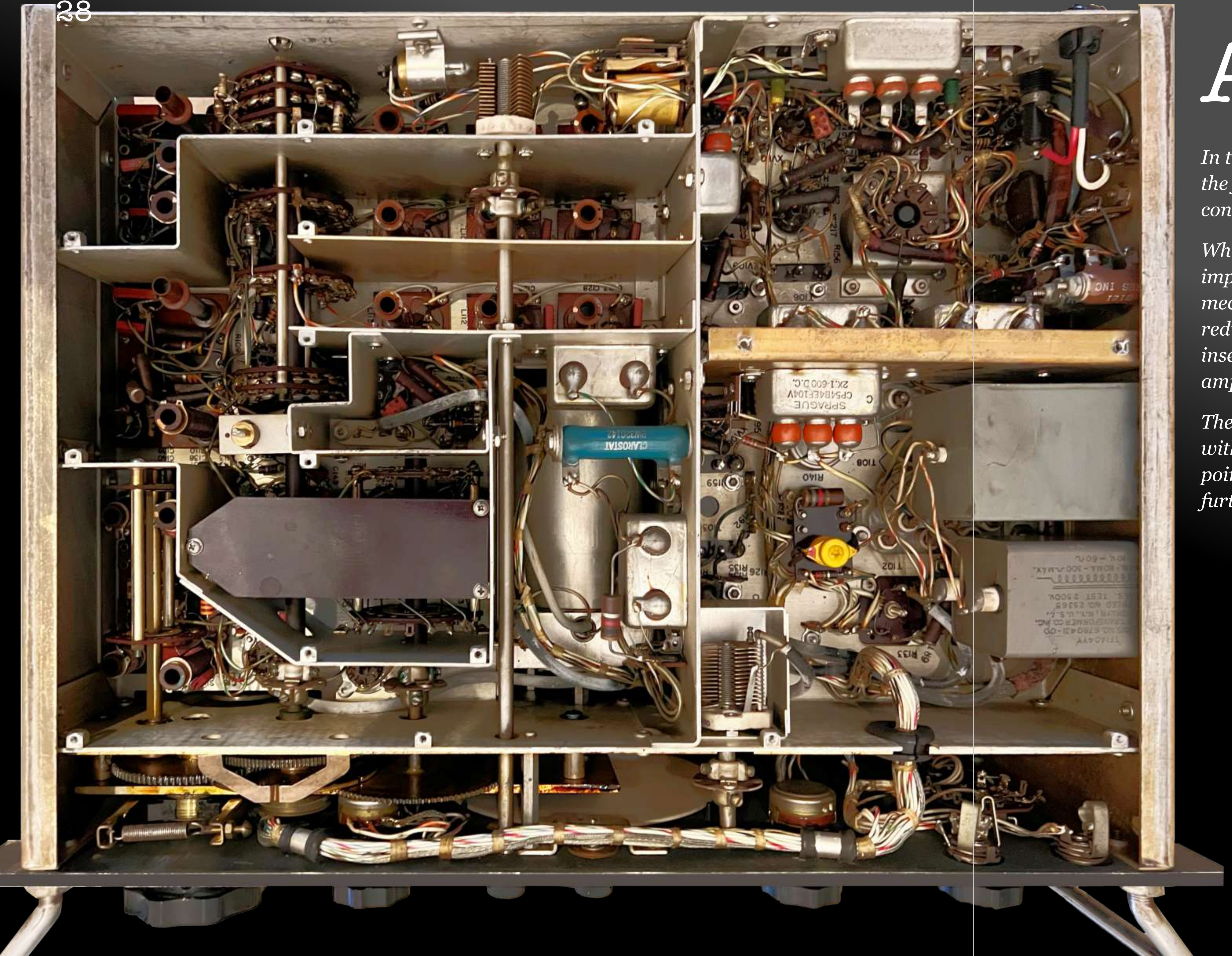
The Collins 51J (military R-388/URR) represented an important technological improvement over the the solutions of WW2. The increasing use of RTTY for data communication required very stable, drift-free receivers, with accurate frequency readout, in addition to the normal requirements for AM and CW signals.

This series of receivers, intended for the military or commercial users, first appeared in 1949 and, over the years, improvements were incorporated into newer versions. The -4 version (mine, here in the photos) was manufactured from 1959 to 1964 and was the last and best model produced, thanks to the Collins' famous mechanical IF filters.

The most visible improvement respect to WW2 receivers, was the tuning scale, composed by a linear indicator displaying the selected 1 MHz segment with 100 kHz marks, and the large and smooth tuning knob, with a circular dial, calibrated with 1 kHz marks, allowing thus an accuracy of around 500 Hz.

To do that, the 51J used the PTO technology (Permeability Tuned Oscillator), that we have already seen in the ARC-2 receiver/transmitter, and that we will meet again in R-390 and R-392 receivers and in the T-195 transmitter.


COLLINS
TYPE
SERIAL
COLLINS RADIO COMPANY
CEDAR RAPIDS, IOWA, U.S.A.
CRYSTAL FILTER
SELECTIVITY
PHASING
METER
INPUT
OUTPUT
MEGACYCLES
KILOCYCLES
BFO
OFF
ON
BFO PITCH
1 KC
3 KC
6 KC
CALIBRATE
AVC
LIMITER
OUT
IN
BAND CHANGE
STAND BY
RF GAIN
AUDIO GAIN
PHONES
SPEAKER
CAL.
ZERO
ADJ.
ANT.
TRIM



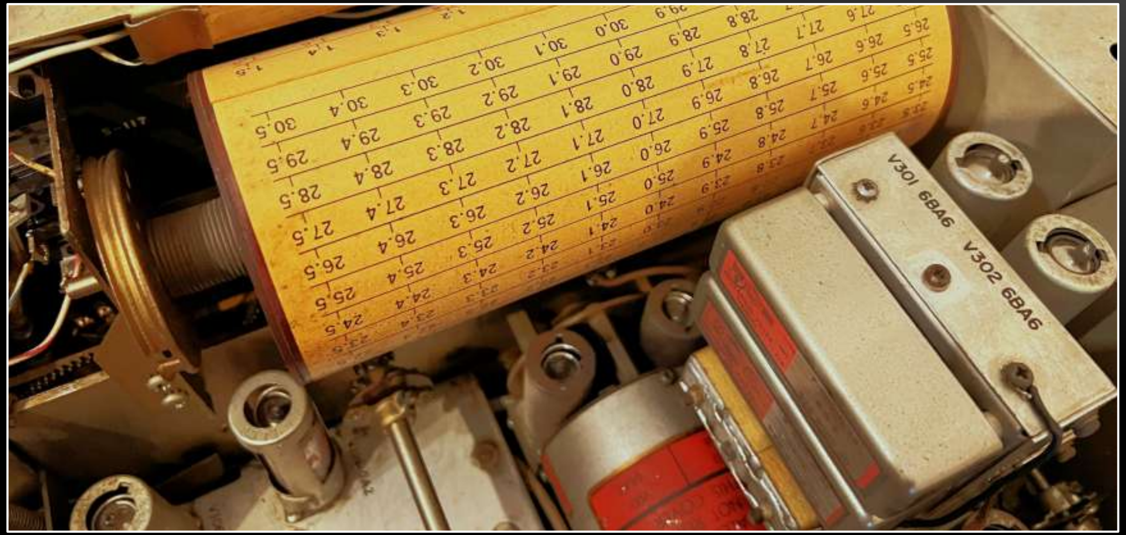
A new age begins

In the Collins 51J, as we said, we find solutions that will be reused and improved in the following devices designed by Collins. It has not yet, however, the modular construction that will be one of the success factors of the subsequent equipment.

When HF band congestion increased, the selectivity became more and more important. In 1955, Collins introduced a new technological leap to 51J-4: three mechanical filters, providing an improved IF passband curve, that dramatically reduced the interference from adjacent frequency signals. To compensate for the insertion loss of the mechanical filters, the 51J-4 added a fourth stage of IF amplification, bringing the tube number to 19.

The 51J4 is less appealing than the subsequent R-390, with its digital readout, but, with the introduction of new concepts, it probably represented the real turning point toward a new age, that will be the swan song of the tube era. I find it, furthermore, very pleasant to use and still an excellent HF receiver.

In the large photo on the left: the 51J4 from the bottom. In the photo below: the rotating drum with the 1 MHz segments. Also the PTO is visible (the silver cylinder with the red label). On top of it, the mechanical filters.

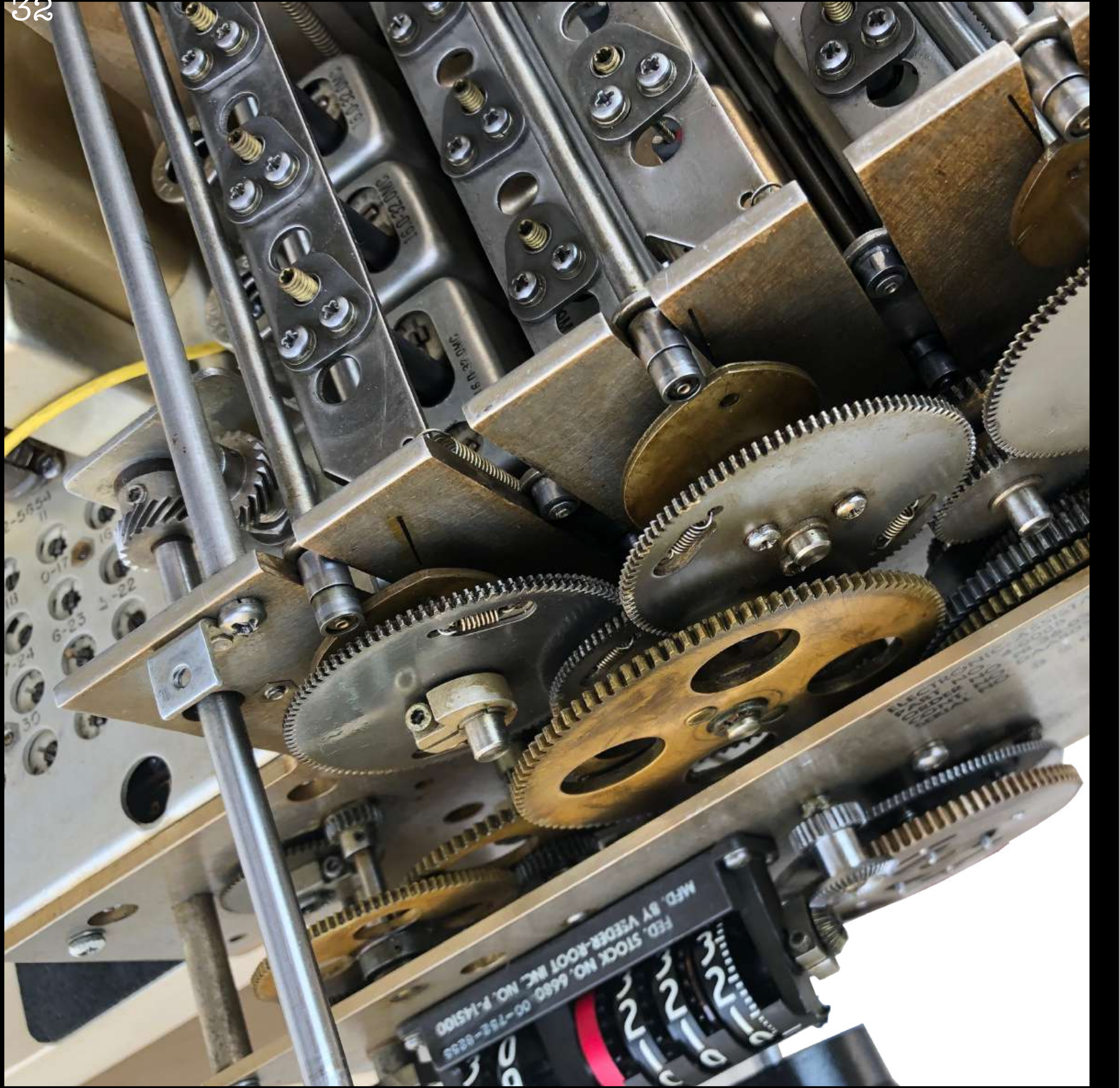


LINE LEVEL
LINE METER
OFF
+10
0
-10
AUDIO RESPONSE
SHARP
WIDE
BANDWIDTH
KC
1
2
4
8
16
BFO
PITCH
BFO
OFF
ON
LOCAL GAIN
DIAL LOCK
CAUTION
READ INSTRUCTIONS PACKED
WITH EQUIPMENT BEFORE USING
PHONES
RECEIVER, RADIO R-390A/URR
ELECTRONIC ASSISTANCE CORPORATION
115/230 VAC
KILOCYCLE CHANGE
BREAK IN
OFF
ON
FUNCTION
STAND BY
AGC
MGC
CAL
OFF
MEGACYCLE CHANGE
ZERO ADJ.
RF GAIN

1951

R-390, His Majesty

The R-390/URR is perhaps the best known, luxury surplus equipment, similar to an Alfa Romeo car or a Rolls of that time. Many consider Collins R-390/URR, with its digital frequency readout, the top of the post-war tube technology. But, as we will see later, perhaps there is something even more advanced...


MFD. BY VEEDER-ROOT INC. NO. P-145100
FED. STOCK NO. 6680-00-752-8235

I want to be digital!

Still in the sixties, a digital readout was not present even in most science-fiction movies. All the instruments were analog, with beautiful hands and complex scales. The R-390 receiver was thus an absolute novelty indeed and remained classified for some years. At that time, on most radio equipment, you were lucky when you could quickly read the frequency and appreciate 100 kHz. With the 390, you could immediately read it down to 1 kHz and any scale mark is 200Hz, with excellent stability… beyond science-fiction!

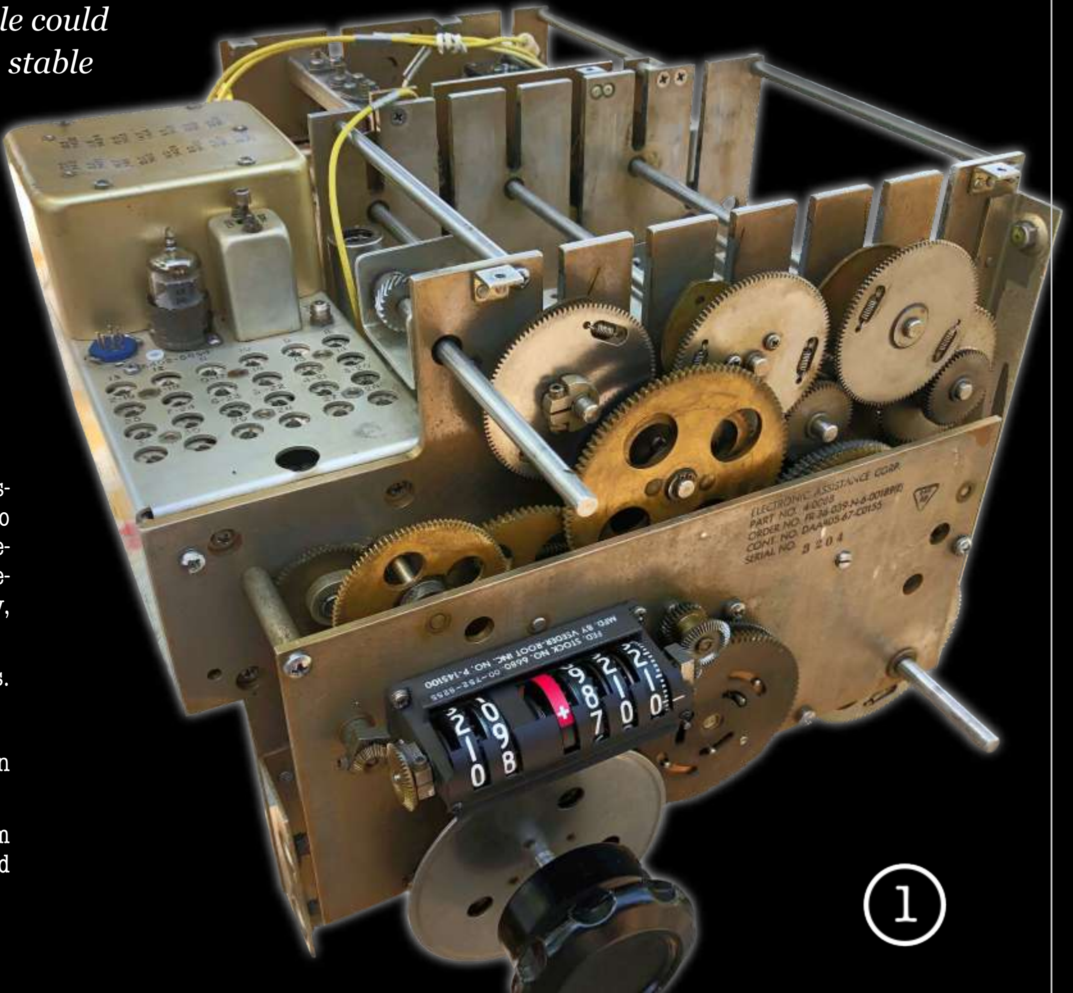
The design that made possible the R-390 was not completely new: it was already present in the civil 51J Collins receiver (military R-388/URR), but it had been improved and apparently fully renewed by adding the counter, made by Veeder-Root, the company famous all over the world for the gasoline pumps.

All the other technical data were first class as well, and still today the R-390 remains, after near 70 years, an excellent HF receiver. Perhaps Collins wanted to amaze even too much, without worrying about cost constraints, and was forced to step back with a less expensive variant, the 390A (same performances, lower production cost).

I today own again a 390, in the A version. I was lucky: I got a well-conserved one, with almost no oxidation. It is incredible how perfect are still the "clicks" of the switches and how the mechanisms run smoothly. Easy to understand that each unit costed the USA government as much as a small family house…

A linear scale

A typical problem with analog electronics is that most circuits have a non-linear behaviour. So, for example, it is not easy indeed to have a linear tuning scale, i.e. to make that the same angle of movement of the knob corresponds to the same frequency variation. In many cases, in surplus equipment, this problem has been solved by simply drawing a non linear scale, but in that way you can appreciate, maybe, 1 kHz in a part of the scale and 20 kHz at the other extreme. And that isn't, definitely, what we want. A solution could be to create a variable capacitor with properly shaped plates. Collins preferred, at that time, the use of a variable inductor for frequency variation, typically a ferrite slug more or less deeply introduced in a coil. To solve the linearity problem, Collins designers decided to control this movement by mean of a properly shaped cam, whose profile could compensate the linearity in a very stable and elegant way. That required a complex gear, which sensibly increased the costs, but which make us enthusiasts very happy... Once the gear had been designed, adding the counter is almost trivial (but it required by itself other technology as well).



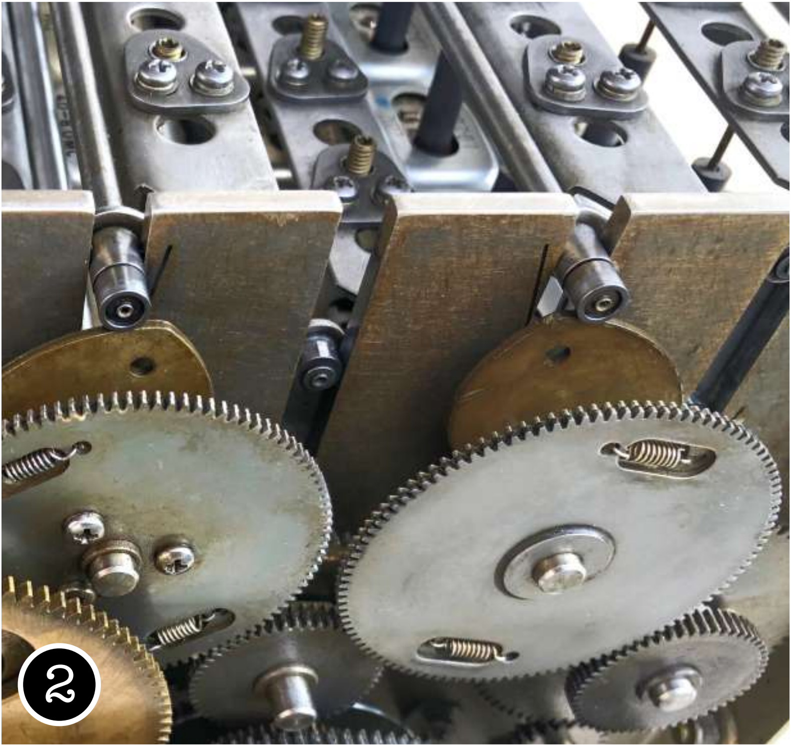
❶ The wonderful R-390 RF chassis is a real masterpiece. Many synchronized cams allows to tune at the same time all the stages of the receiver. In the photo all the transformer were removed. Their replacement is incredibly easy, with no need for soldering.

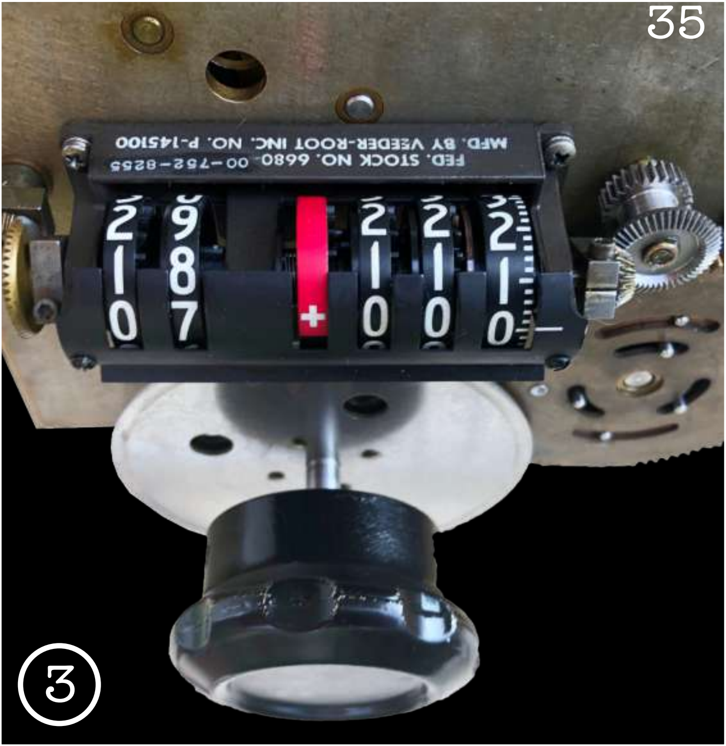
❷ This detail shows the cams, behind the gears.

❸ The Veeder-Root counter

❹ The silver plated antenna relay could be an ornament in your lounge.

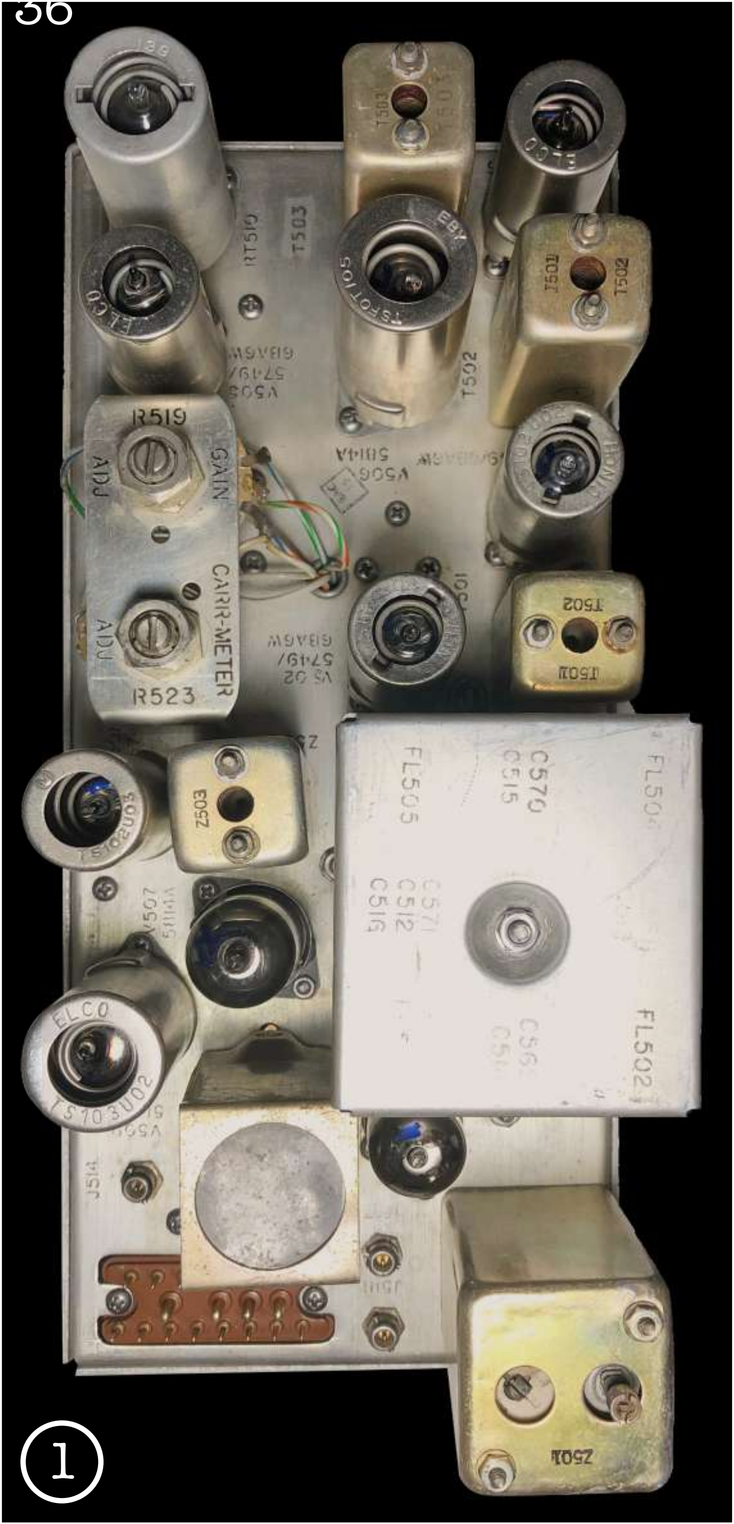
❺ The line meter indicator allows to perform sensitivity tests without an external dedicated multimeter.




FED. STOCK NO. 6680-00-752-8255
MFD. BY VEEDER-ROOT INC. NO. P-145100
③

-20 -10 -5 VU +1 +2 +3
0 50 100
59.1034
⑤

The 390



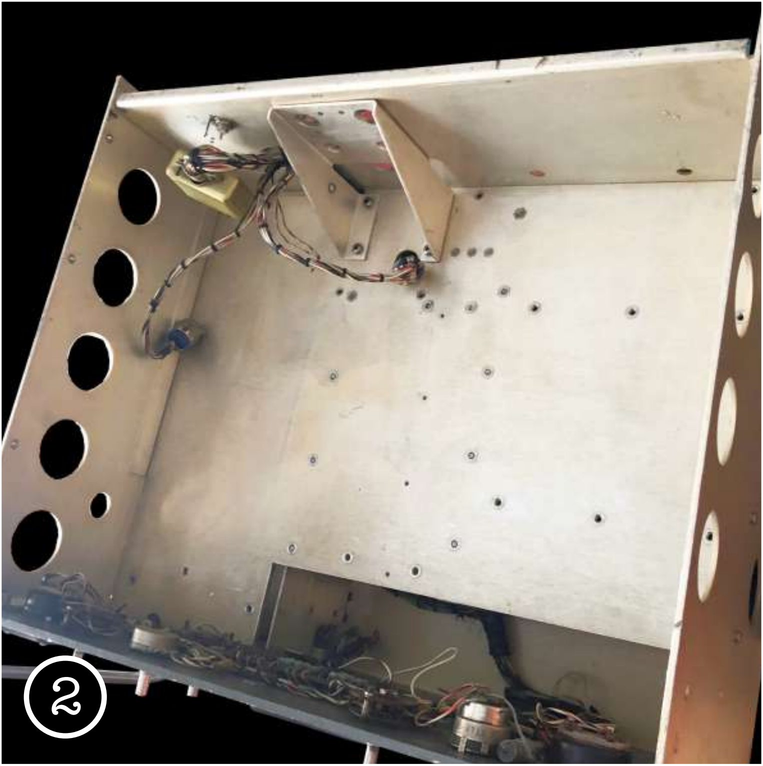
①

Modular!

As we told, modularity is a big plus of R-390. In the photo 1, you can see the IF-chassis, which can be removed rather easily in few minutes, being also connected by a removable connector. In photo 2, you can see the upper part of the mainframe emptied by all the modules, while on the right you can see the R-.390 almost completely spoiled.

All that is a notable advantage also for us restorers, because it allows to deeply clean and inspect most of the parts.

❶ The IF chassis. Note the big square silver box: it is the famous mechanical filter that, in addition to many other things, makes R-390 so special.
❷ The empty mainframe. Note the connectors that link the various modules. No connection is required to be cut or unsoldered.
❸ The disassembled mainframe. The strange strip on the corner is used to ensure the ground contact of the RF-chassis.



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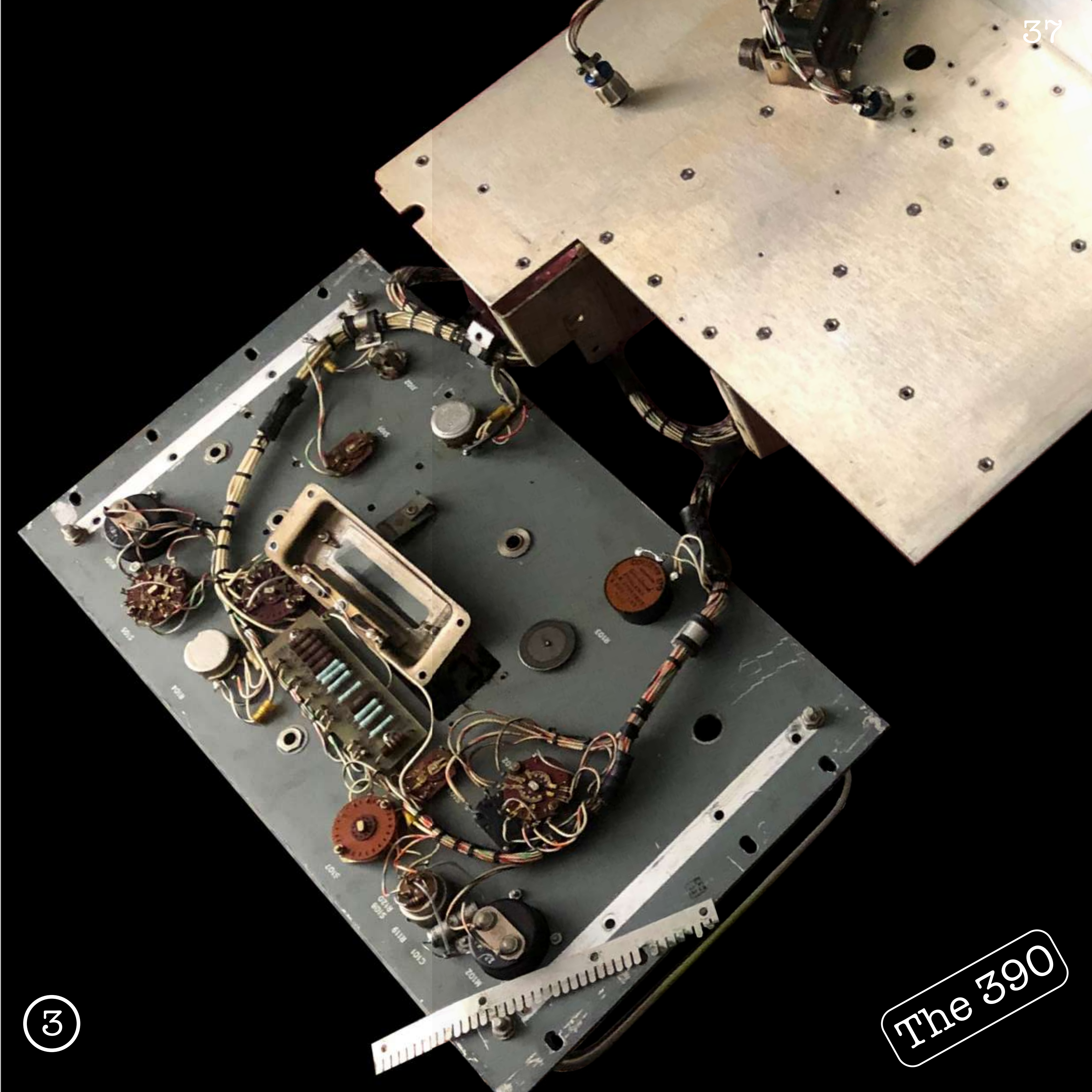
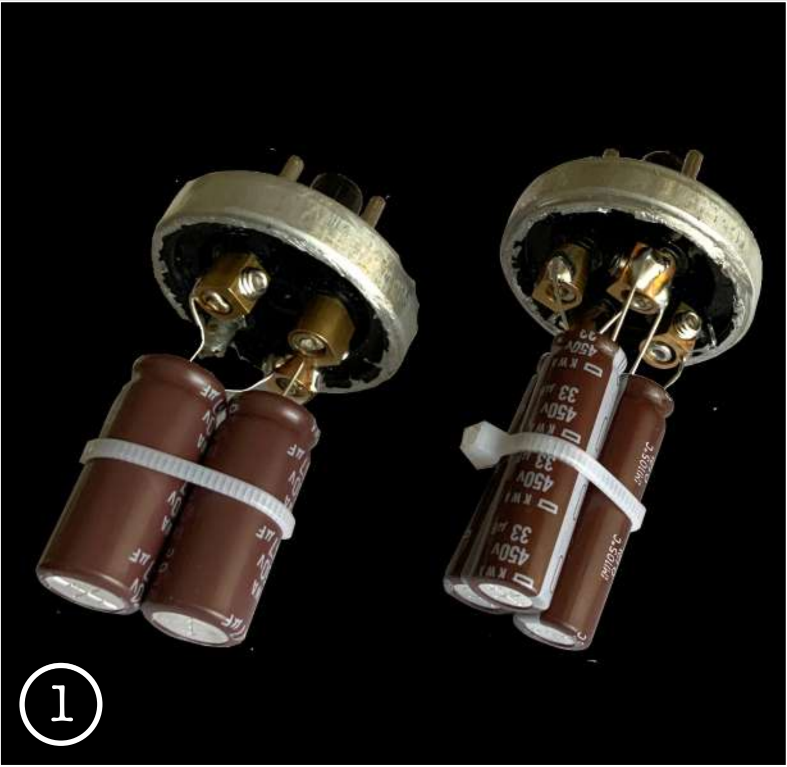


③

Typical problems

An old equipment has always some problems. Resistors can drift their value (often increasing) and capacitors may start to leak current. Particularly, filter electrolytics in power supplies are the most dangerous, because they put at risk the mains transformer and might even explode. In my 390A, they were starting to collapse, but luckily only one resistor was burned. A tool like ZM-11/B (see later) is precious for the diagnosis. You can repair them in many ways, but I wish to preserve also the aesthetic aspects, so I cut their can with a Dremel, patiently emptied it, and installed modern electrolytics (photo 1). At the end, I closed the can again with a strong glue and some turn of a technical Scotch tape.

Another typical problem is represented by the capacitive trimmers rubber gasket (they are a lot, in the RF transformers and in the crystal oscillator chassis); see for example those indicated by the red arrow in photo 3. Dismounting them in pieces (photo 2) is not too difficult but you need to proceed carefully as when you defuse a bomb, to avoid damaging them...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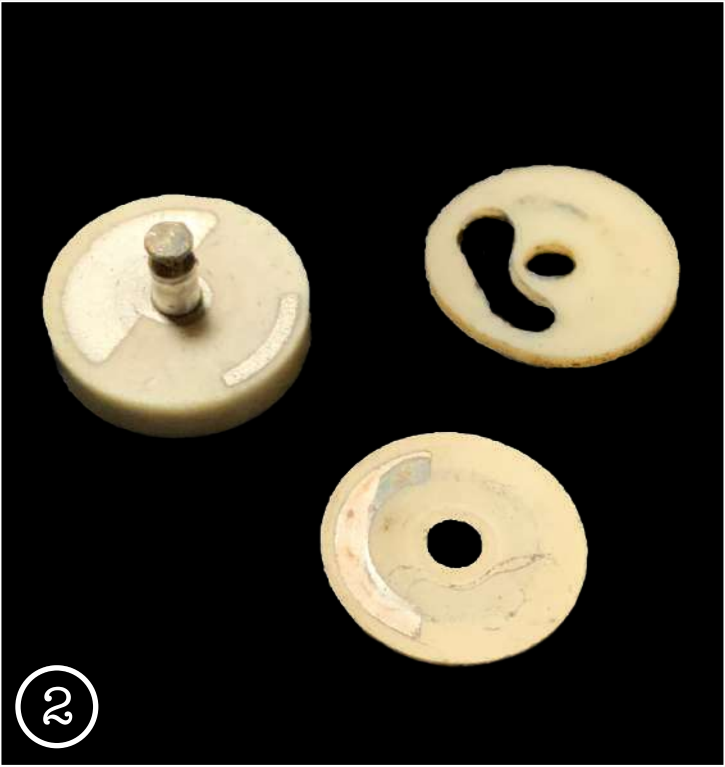
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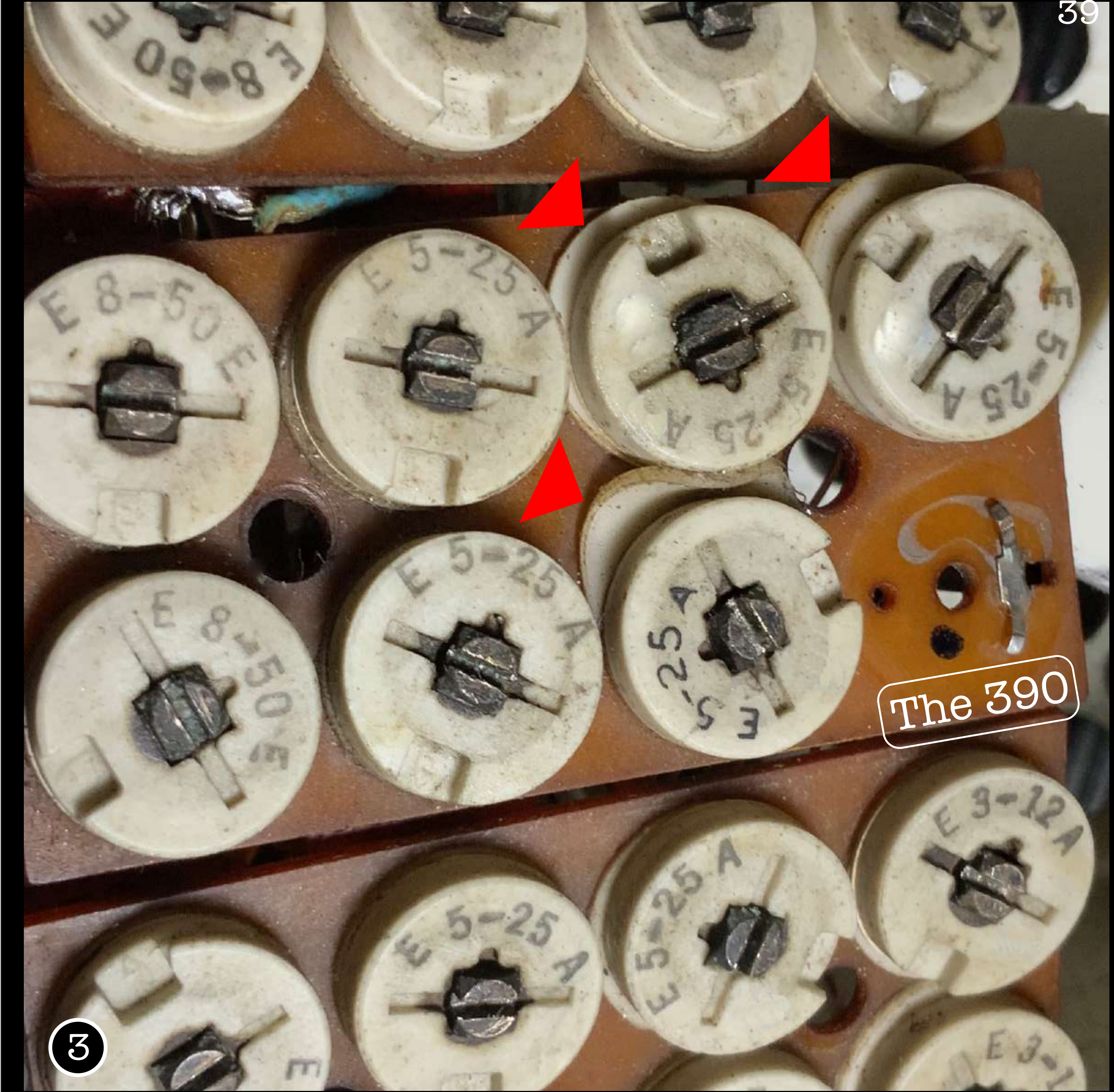

③

More on the 390

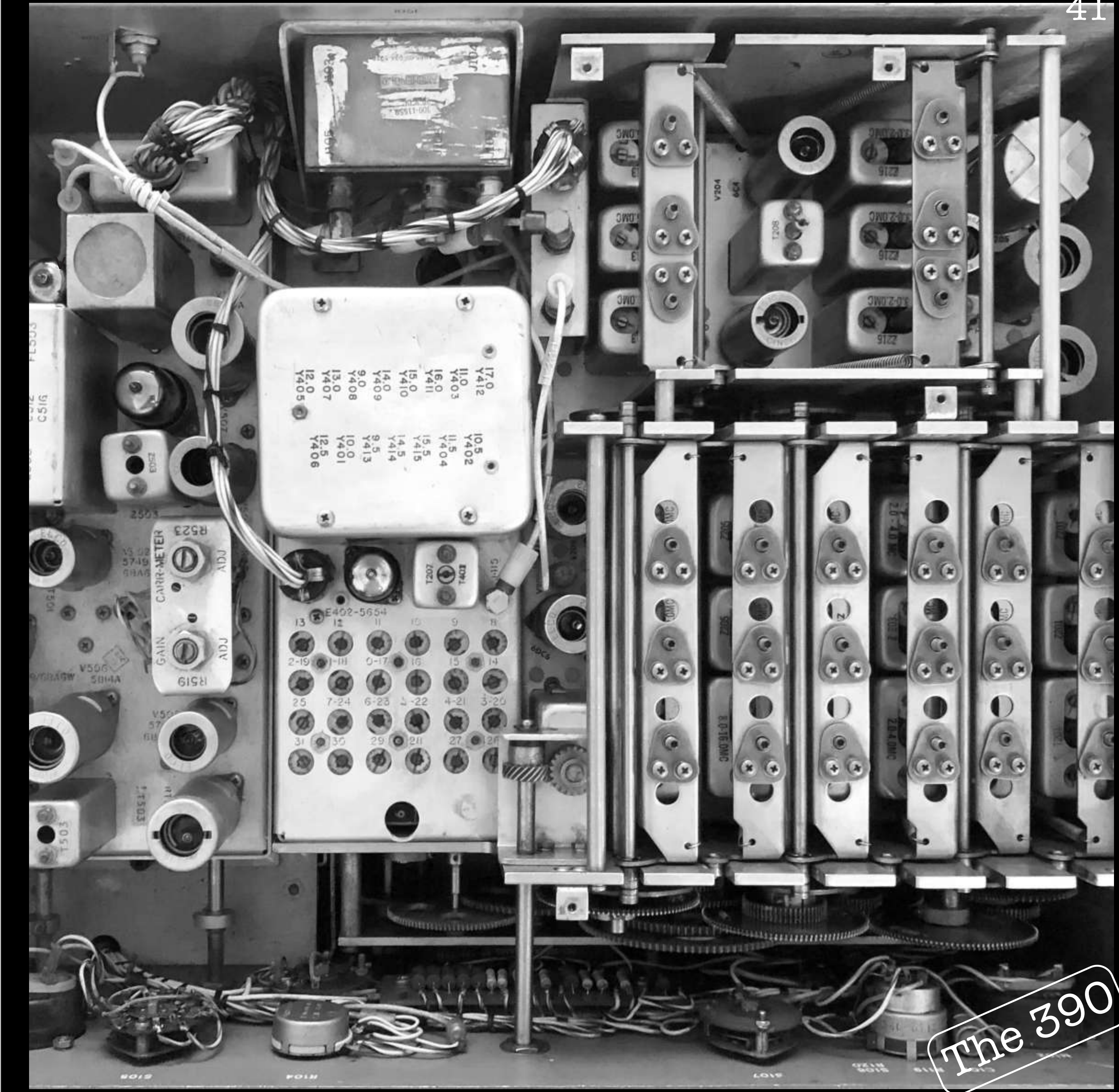
The first version of this incredible receiver was the R-390 featuring 33 tubes, double or triple conversion, two RF stages, six IF stages, modular construction, three audio filter settings, six selectivity bandwidths and frequency coverage from 500 kc. to 32.0 mc. in 32 - one megacycle wide - bands. It is a high performance receiver that really "shows its stuff" when conditions are poor, but will also provide fairly nice audio quality when receiving conditions allow for it.

Collins designed a replacement receiver that was introduced in 1954 with the designation of R-390A/URR. Though the new receiver looked very similar externally to the R-390, inside numerous changes were made to improve cost-to-performance and ease of maintenance. The new receiver's gear box was removable as a unit and synchronisation would be maintained, the crystal oven just plugged into the Crystal Oscillator module (it is secured by screws though,) the B+ voltage regulator circuit became a standard 0A2 tube, the crystal calibrator was combined into the RF module (eliminating the separate Crystal Calibrator module of the R-390) and the Crystal Oscillator module was mounted to the RF module so removal of the entire RF deck kept everything synchronised together except the PTO. All of the maintenance "quirks" of the R-390 were corrected in the R-390A which made the receiver easy for the military to maintain. The major performance change involved the installation of four mechanical filters in the IF section of the receiver. The steep slopes of the mechanical filters gave the R-390A excellent selectivity on 16KC, 8KC (really about 11KC,) 4KC and 2KC bandwidths. The 1KC and .1KC bandwidths are crystal filter derived from the 2KC wide setting.

The R-390A uses 26 tubes (including the 3TF7 ballast tube) with one RF stage, four IF stages, mechanical filters on four of the six selectivity positions, plus an 800Hz audio filter. When properly set-up, an operator can dig right through the QRM while maintaining fantastic sensitivity making the R-390A one of the finest tube-type receivers ever built. The R-390A was produced in yearly contracts from 1954 up through 1967 (and some very small contracts in 1968 and 1984) with many different contractors building the receivers during those years.

The R-390 and R-390A receivers have provided reliable communications under adverse conditions for years and even though the design and nearly all of the receivers are over 50 years old, they are still one of the best tube-type receivers around.

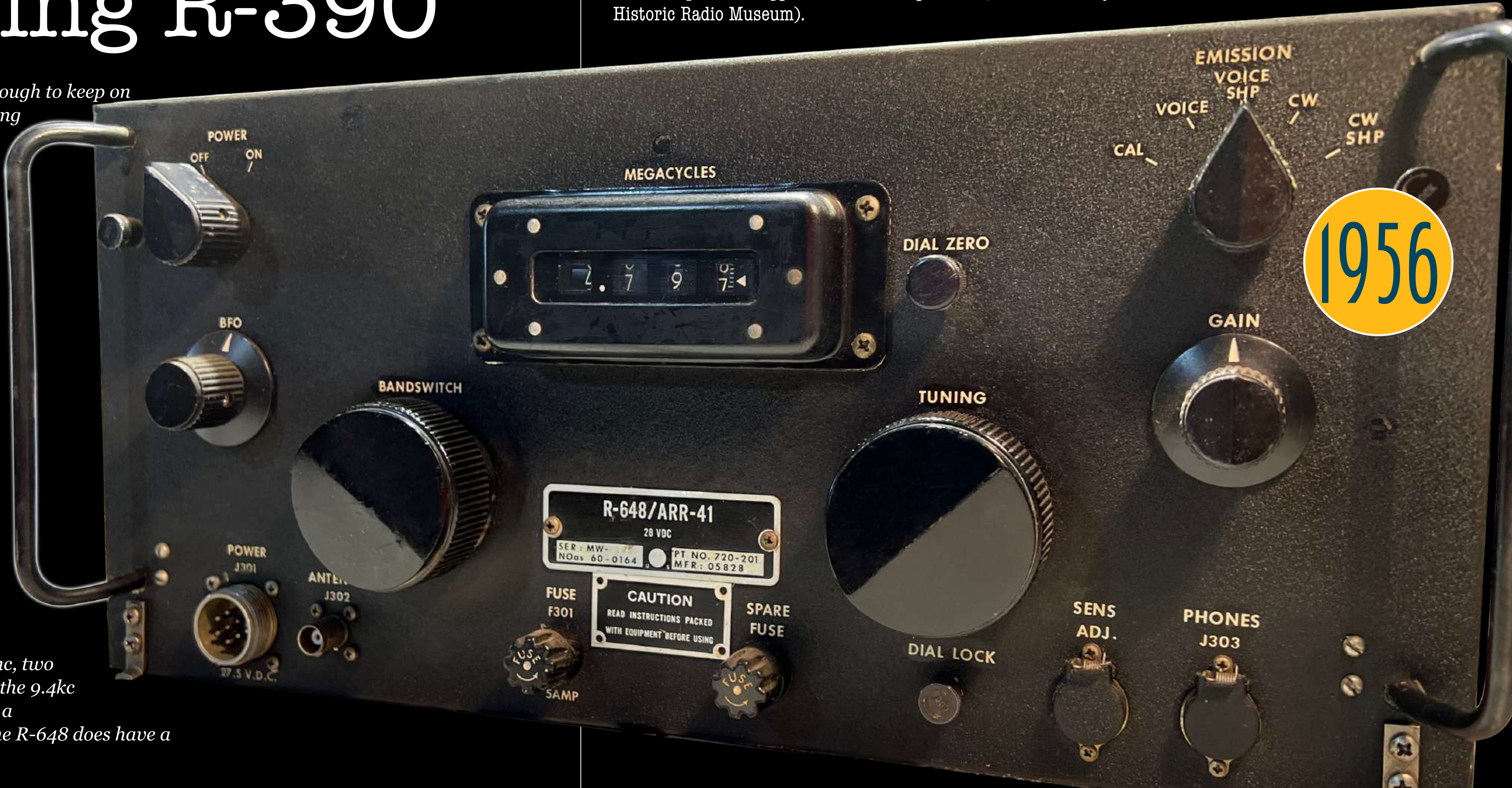
(from Radio Boulevard - Western Historic Radio Museum where you can find the best description of this equipment and super-valuable notes on its restoration)



R-648 / ARR-41
The flying R-390

A R-390 receiver is heavy but not enough to keep on ground an airplane. But, on something that is going to fly, weight is essential, and any equipment installed on it must be as light as possible.

Collins had so to designed the R-648/ARR-41, the so-called "Airborne R-390A". Collins' engineers borrowed a lot of the circuitry from the 51J Series of receivers. Rather than the 80 pound, hefty-weight of a R-390A, the R-648 weighs-in at about 30 pounds. To achieve this lighter weight package, the receiver is much smaller, with reduced-size mechanics and components. Of course, some of the R-390A features and circuits are not even present. Still, with 17 tubes that provide two RF amplifiers, three 500kc fixed-frequency IF amplifiers, frequency coverage from 190kc to 550kc and from 2mc to 25mc, two mechanical filters (9.4kc and 1.4kc - the 9.4kc MF was later changed to 6.0kc) and a mechanical digital frequency dial, the R-648 does have a few "R-390A" features. The circuit conversion methods were borrowed from the 51J/R-388 by using a dual variable IF and fewer crystals in the Crystal Oscillator along with the 500kc IF. Double conversion is used on all frequency ranges except for the 2-3mc band and the 3-4mc band where single conversion is used. Audio output has three stages and was designed for a headset of 300Z ohms or greater. Typical antenna input Z is 50 ohms (freely taken from Radio Boulevard - Western Historic Radio Museum).

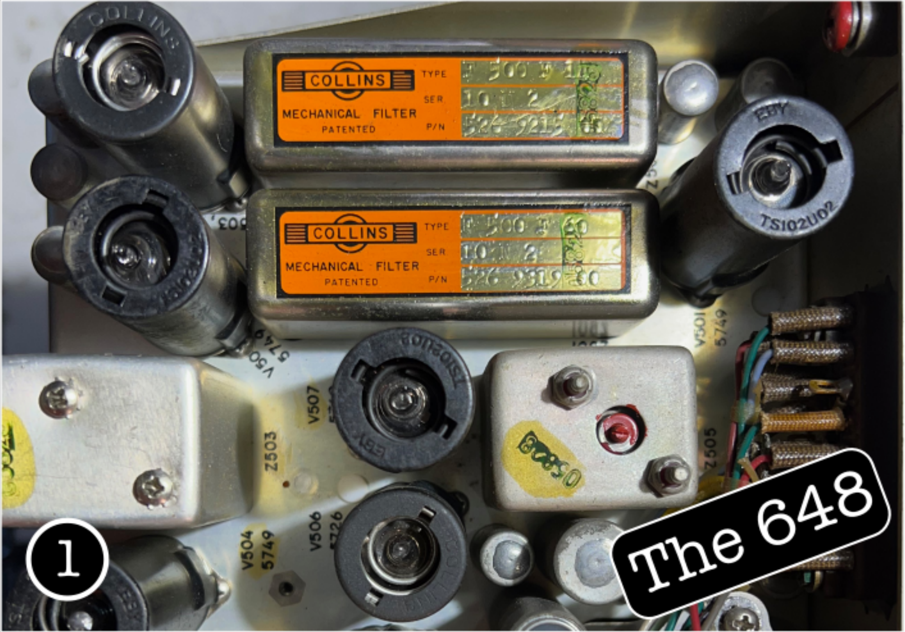

POWER
OFF
ON
MEGACYCLES
DIAL ZERO
EMISSION
VOICE SHP
VOICE
CW
CW SHP
CAL
BFO
BANDSWITCH
TUNING
GAIN
R-648/ARR-41
28 VDC
PT NO. 720-201
MFR: 05828
CAUTION
READ INSTRUCTIONS PACKED WITH EQUIPMENT BEFORE USING
FUSE
F301
SPARE FUSE
DIAL LOCK
SENS ADJ.
PHONES
J303
POWER
J301
27.5 V.D.C.
J302

1956

The magnificent R-648/URR represented in these pages, and the R-725 below, are owned by ***Francesco Sartorello****, one of the biggest Italian surplus collector, whom I thank for its great contribution to my collection.*

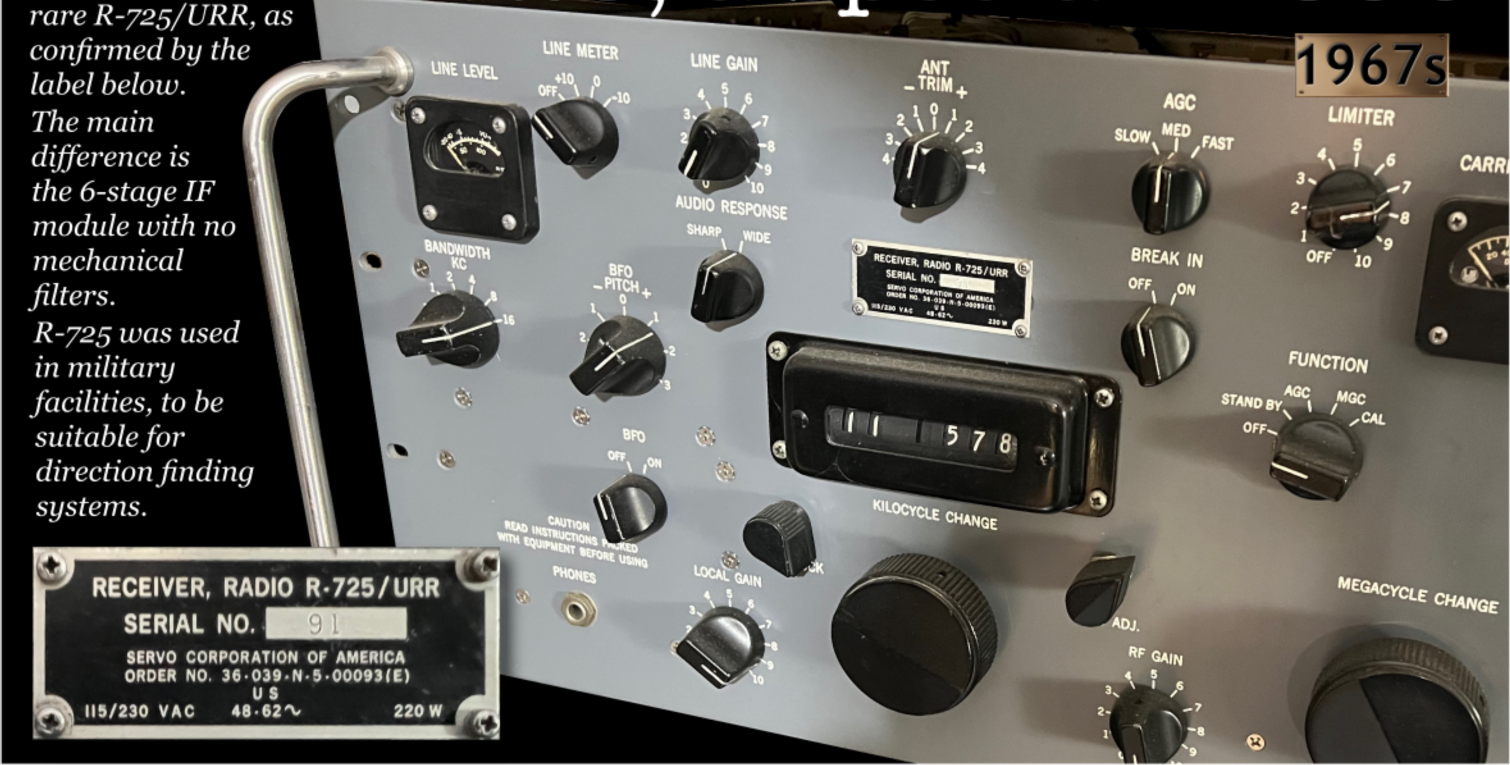
❶ The R-648's mechanical filters are similar to the ones used in 51J4 receiver.

❷ The R-648's interior. It construction is completely modular,. Differently from the R-390, also the front panel is linked with a detachable connector. Note the mechanics, in pure Collins' style, the VFO's PTO and the calibrator crystal, similar to R-390 and R-392 (pointed by the red arrows). The power supply has been rebuilt to operate with mains instead of the dynamotor.

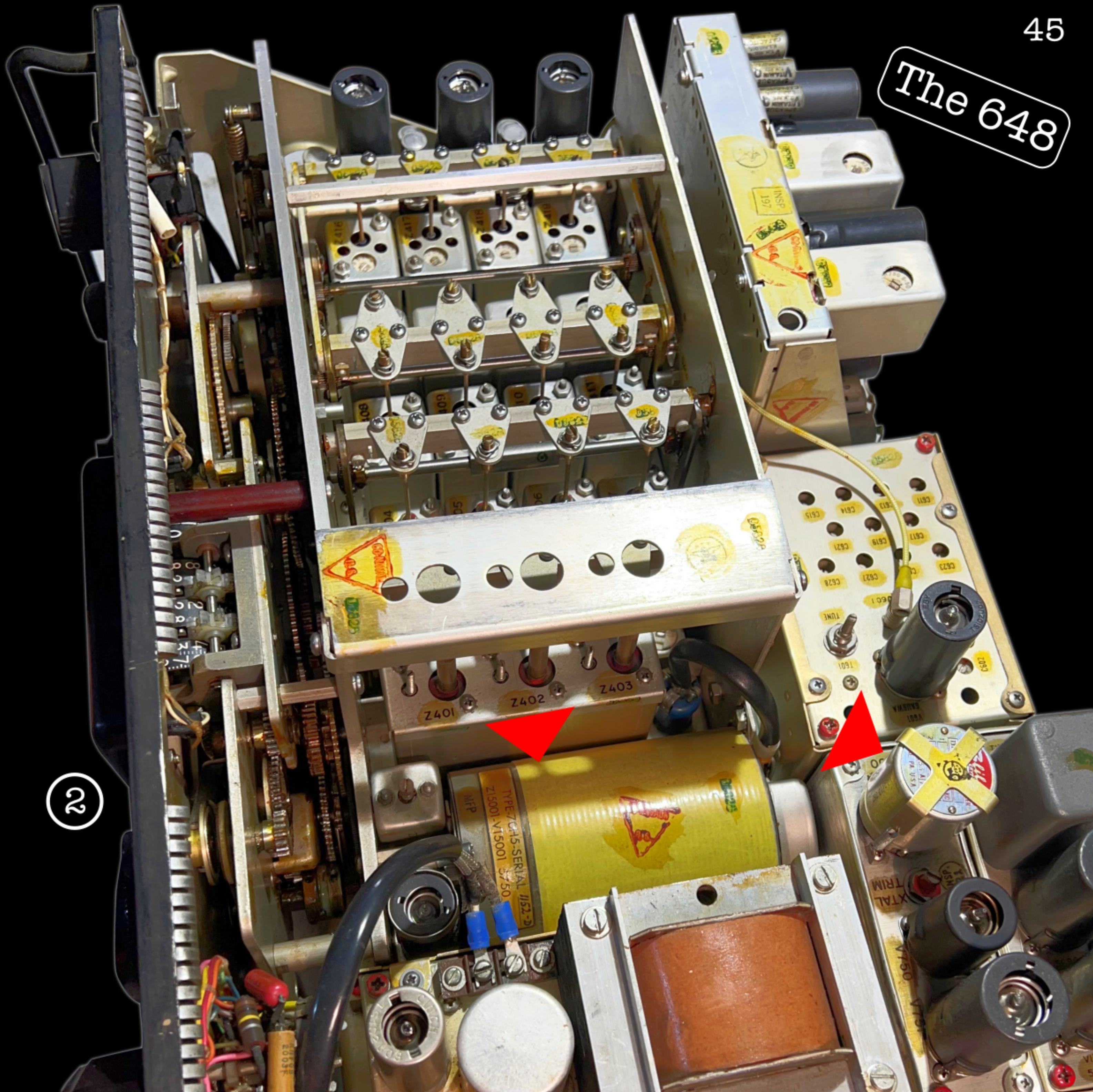

①
The 648
COLLINS
MECHANICAL FILTER
PATENTED
COLLINS
MECHANICAL FILTER
PATENTED

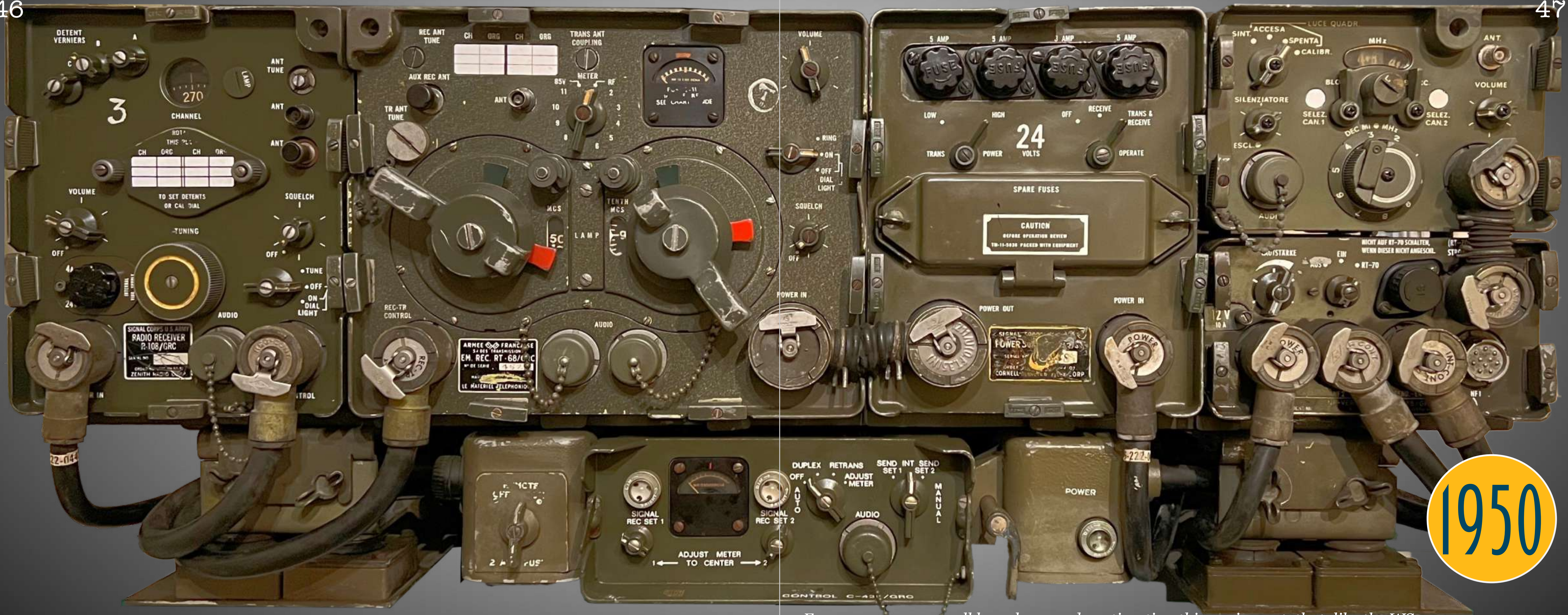
R-725, a special R-390

This in the photo is not an R-390A but a rare R-725/URR, as confirmed by the label below. The main difference is the 6-stage IF module with no mechanical filters. R-725 was used in military facilities, to be suitable for direction finding systems.


1967s
LINE LEVEL
LINE METER
LINE GAIN
ANT TRIM
AGC
SLOW
MED
FAST
LIMITER
CARR
BANDWIDTH KC
AUDIO RESPONSE
SHARP
WIDE
BFO PITCH
BREAK IN
OFF
ON
FUNCTION
STAND BY
AGC
MGC
CAL
BFO
KILOCYCLE CHANGE
MEGACYCLE CHANGE
PHONES
LOCAL GAIN
RF GAIN
ADJ.

RECEIVER, RADIO R-725/URR
SERIAL NO. [redacted]
SERVO CORPORATION OF AMERICA
ORDER NO. 36-039-N-5-00093(E)
U S
115/230 VAC 48-62~ 220 W


The 648
②
Z401
Z402
Z403


DETENT VERNIERS
CHANNEL
VOLUME
SQUELCH
TUNING
AUDIO
SIGNAL CORPS U.S. ARMY RADIO RECEIVER R-108/GRC
ZENITH RADIO
REC ANT TUNE
AUX REC ANT
TR ANT TUNE
TRANS ANT COUPLING
METER
TENTH MCS
LAMP
REC-TR CONTROL
ARMEE FRANÇAISE EM. REC. RT-68/GRC
LE MATERIEL TELEPHONIQUE
POWER IN
SPARE FUSES
CAUTION
24 VOLTS
POWER OUT
SILENZIATORE
SELEZ. CAN. 1
SELEZ. CAN. 2
SIGNAL REC SET 1
SIGNAL REC SET 2
ADJUST METER TO CENTER
DUPLEX
RETRANS
AUDIO
MANUAL
POWER
CONTROL C-435/GRC

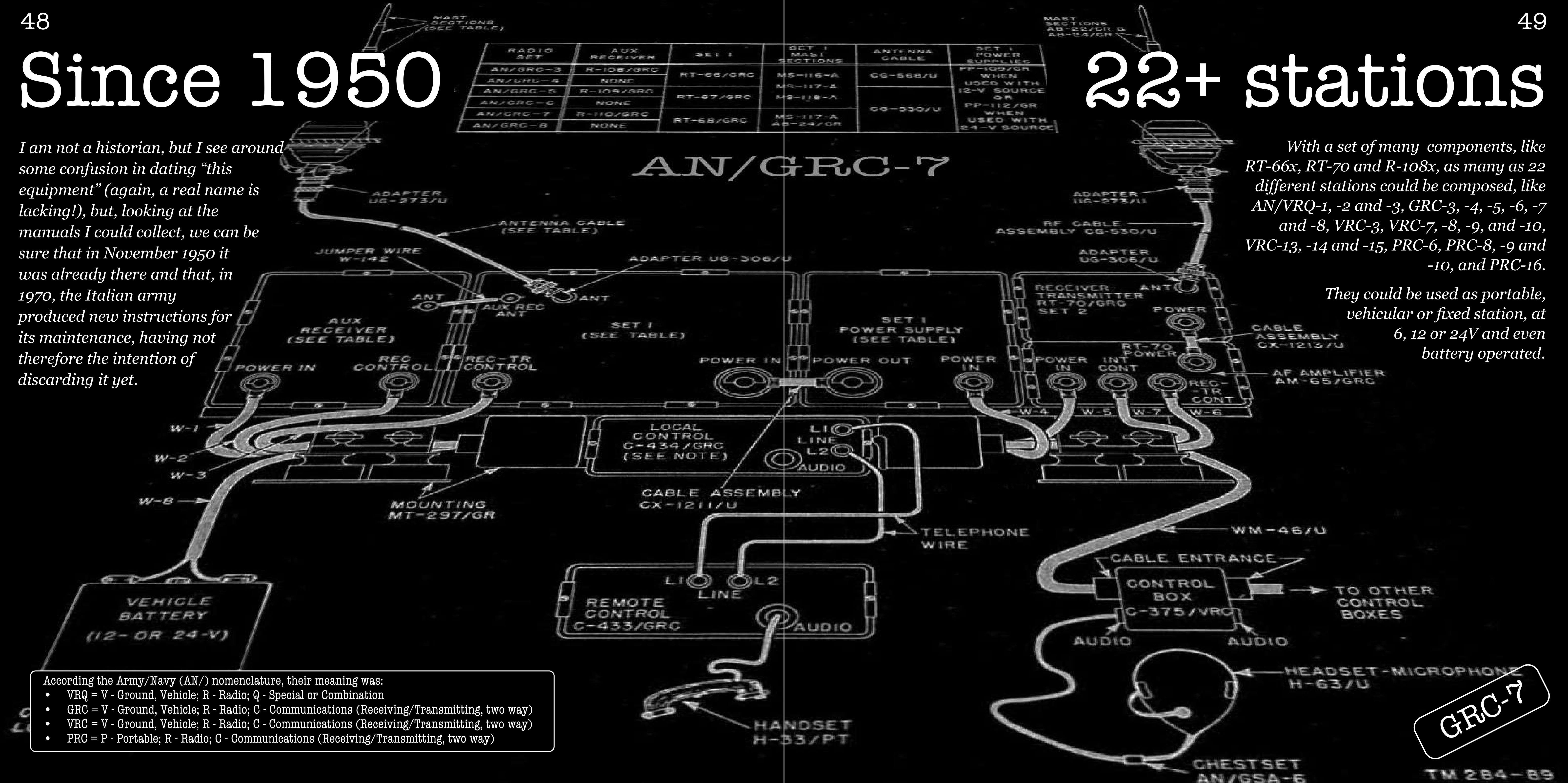
1950

AN/GRC-7

For many years, we all have been underestimating this equipment, that, like the WS 19, was more a modular system composed by many different pieces than just a single unit. The first reason for this could be that, until few years ago, surplus was not considered, as today, a piece of technology's history, but was mainly used for its low cost by radio hams, to whom this series was not so appealing. Another reason could be a poor marketing: this system is "confused" and lacks a true name. To refer to it, you should use a very complex and long designation (AN/GRC-3, -4, 5, -6, -7 and -8, VRC-7, -13, 14 etc.). The last explanation could be that it is very easy to find these units on the market, so they have not the charm of rarity. But today we should reconsider them because they are technology jewels.

Since 1950

I am not a historian, but I see around some confusion in dating "this equipment" (again, a real name is lacking!), but, looking at the manuals I could collect, we can be sure that in November 1950 it was already there and that, in 1970, the Italian army produced new instructions for its maintenance, having not therefore the intention of discarding it yet.



RADIO SET	AUX RECEIVER	SET I	SET I MAST SECTIONS	ANTENNA CABLE	SET I POWER SUPPLIES
AN/GRC-3	R-108/GRC	RT-66/GRC	MS-116-A MS-117-A MS-118-A	CG-568/U	PP-109/GR WHEN USED WITH 12-V SOURCE OR PP-112/GR WHEN USED WITH 24-V SOURCE
AN/GRC-4	NONE				
AN/GRC-5	R-109/GRC	RT-67/GRC		CG-530/U	
AN/GRC-6	NONE				
AN/GRC-7	R-110/GRC	RT-68/GRC	MS-117-A AB-24/GR		
AN/GRC-8	NONE				

MAST SECTIONS (SEE TABLE)
AN/GRC-7
ADAPTER UG-273/U
ANTENNA CABLE (SEE TABLE)
JUMPER WIRE W-142
ADAPTER UG-306/U
ANT
AUX REC ANT
ANT
AUX RECEIVER (SEE TABLE)
SET I (SEE TABLE)
POWER IN
REC CONTROL
REC-TR CONTROL
POWER IN
POWER OUT
SET I POWER SUPPLY (SEE TABLE)
POWER IN
W-1
W-2
W-3
W-8
LOCAL CONTROL C-434/GRC (SEE NOTE)
L1
LINE
L2
AUDIO
MOUNTING MT-297/GR
CABLE ASSEMBLY CX-1211/U
TELEPHONE WIRE
VEHICLE BATTERY (12- OR 24-V)
L1
L2
LINE
REMOTE CONTROL C-433/GRC
AUDIO
HANDSET H-33/PT
MAST SECTIONS AB-22/GR & AB-24/GR
ADAPTER UG-273/U
RF CABLE ASSEMBLY CG-530/U
ADAPTER UG-306/U
RECEIVER-TRANSMITTER RT-70/GRC SET 2
ANT
POWER
CABLE ASSEMBLY CX-1213/U
RT-70 POWER
POWER IN
INT CONT
REC-TR CONT
AF AMPLIFIER AM-65/GRC
W-4
W-5
W-7
W-6
WM-46/U
CABLE ENTRANCE
CONTROL BOX C-375/VRC
TO OTHER CONTROL BOXES
AUDIO
AUDIO
HEADSET-MICROPHONE H-63/U
CHESTSET AN/GSA-6
TM 284-89

According the Army/Navy (AN/) nomenclature, their meaning was:

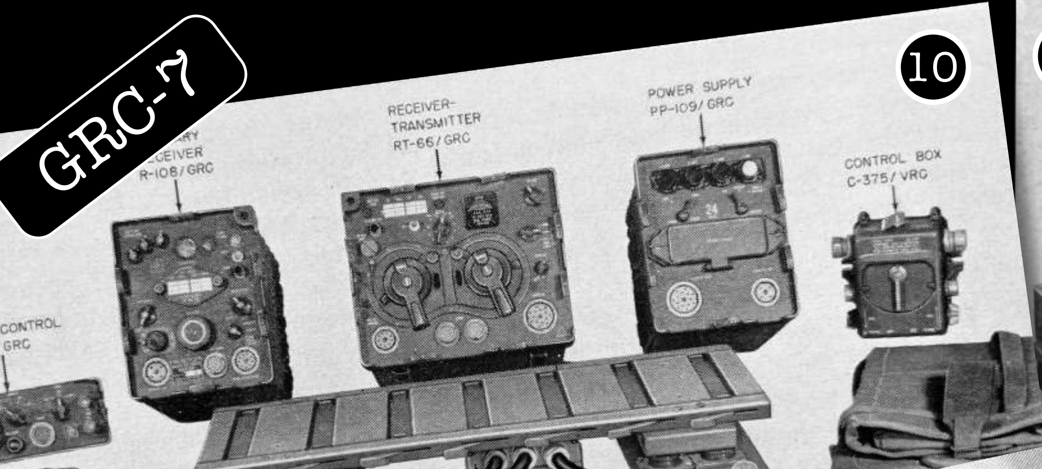
- VRQ = V - Ground, Vehicle; R - Radio; Q - Special or Combination
- GRC = V - Ground, Vehicle; R - Radio; C - Communications (Receiving/Transmitting, two way)
- VRC = V - Ground, Vehicle; R - Radio; C - Communications (Receiving/Transmitting, two way)
- PRC = P - Portable; R - Radio; C - Communications (Receiving/Transmitting, two way)

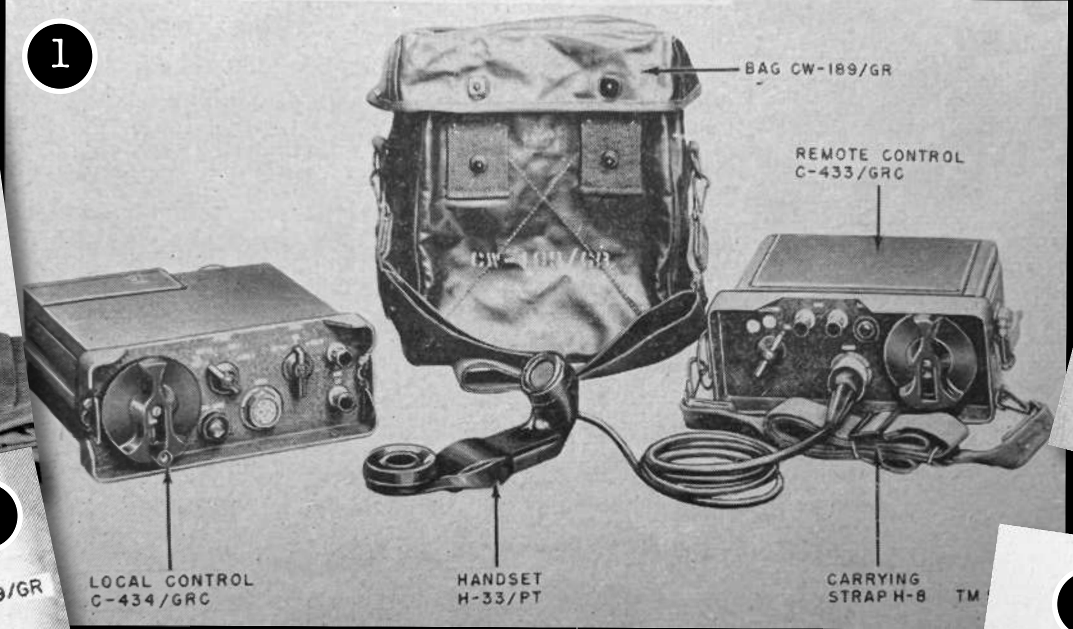
22+ stations

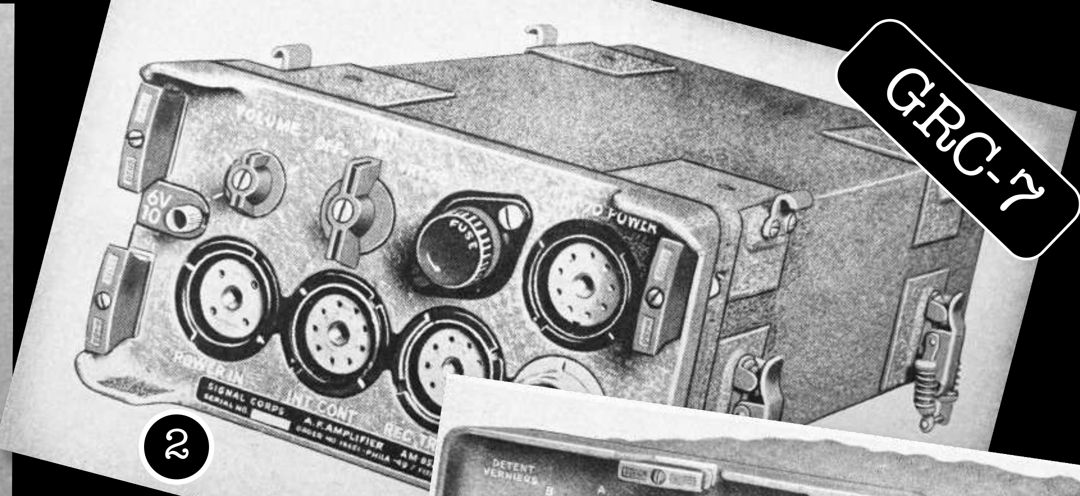
With a set of many components, like RT-66x, RT-70 and R-108x, as many as 22 different stations could be composed, like AN/VRQ-1, -2 and -3, GRC-3, -4, -5, -6, -7 and -8, VRC-3, VRC-7, -8, -9, and -10, VRC-13, -14 and -15, PRC-6, PRC-8, -9 and -10, and PRC-16.

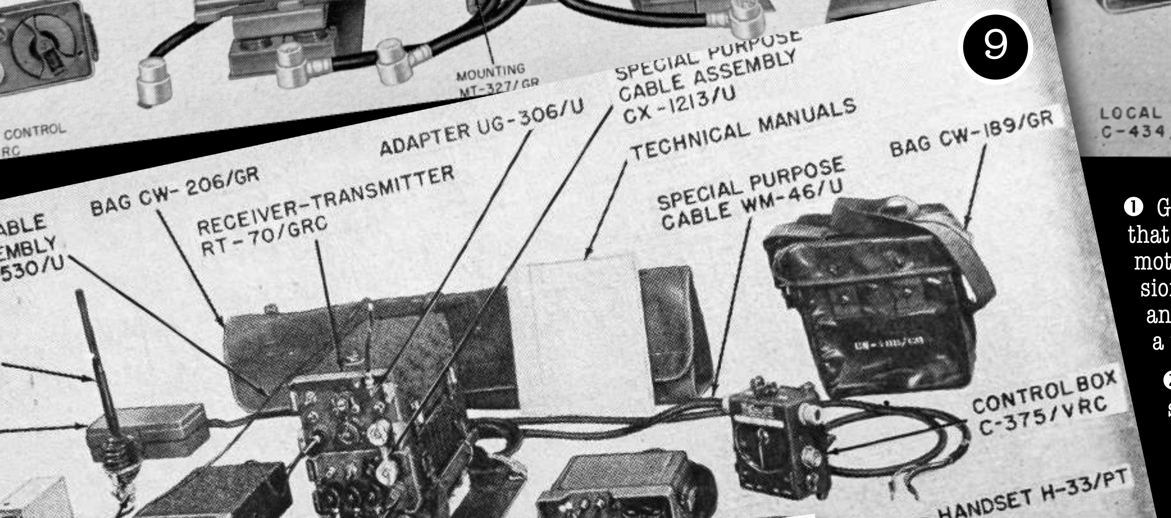
They could be used as portable, vehicular or fixed station, at 6, 12 or 24V and even battery operated.

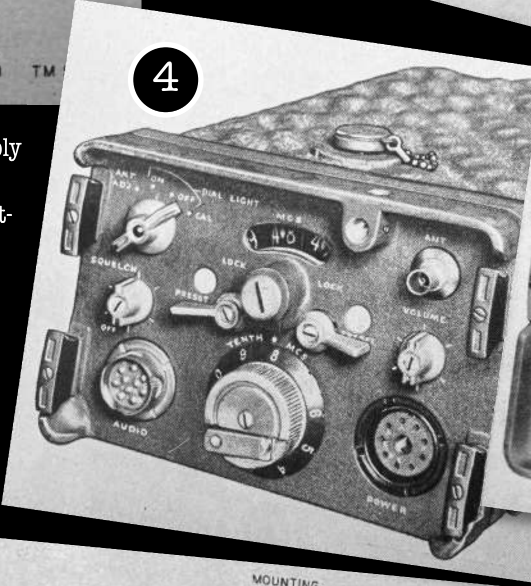
GRC-7


10
CONTROL
GRC
ARY
RECEIVER
R-108/GRC
RECEIVER-
TRANSMITTER
RT-66/GRC
POWER SUPPLY
PP-109/GRC
CONTROL BOX
C-375/VRC
MOUNTING
MT-327/GR
CONTROL


1
BAG CW-189/GR
REMOTE CONTROL
C-433/GRC
LOCAL CONTROL
C-434/GRC
HANDSET
H-33/PT
CARRYING
STRAP H-8
TM


2
VOLUME
POWER
POWER IN
INT CONT
SIGNAL CORPS
AMPLIFIER AM


9
SPECIAL PURPOSE
CABLE ASSEMBLY
CX-1213/U
ADAPTER UG-306/U
TECHNICAL MANUALS
BAG CW-189/GR
BAG CW-206/GR
RECEIVER-TRANSMITTER
RT-70/GRC
SPECIAL PURPOSE
CABLE WM-46/U
ABLE
EMBLY
530/U
CONTROL BOX
C-375/VRC
HANDSET H-33/PT
MPLIFIER
TROL


4
SQUELCH
AUDIO
POWER
VOLUME
ANT

3
DETENT
VERNIERS
CHANNEL
VOLUME
SQUELCH
TUNING
AUDIO
POWER IN
REC CONTROL
TM 898-1

❶ GRA-6, a very interesting accessory, that may be used to provide local or remote control of power and/or transmission and audio connection between local and remote control stations using only a twisted pair line.

❷ AM-65 amplifier is also the power supply to the RT-70.

❸ R-108 (91 & 10) auxiliary receiver

❹ RT-70 receiver / transmitter

❺ PP-112, the 24V power supply for RT-66 (67 & 68) rtx

❻ MT-197, the "large" mounting base

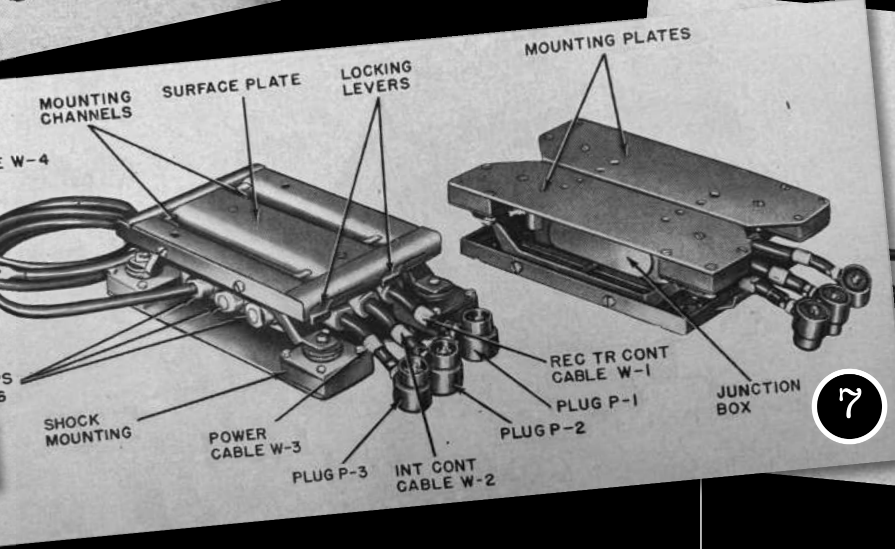
❼ MT-400, the "small" base

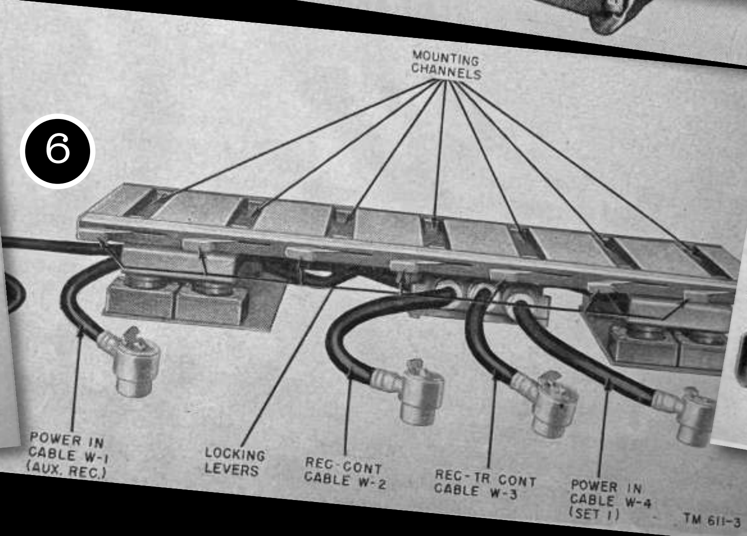
❽ RT-66 (67 & 68) main receiver transmitter

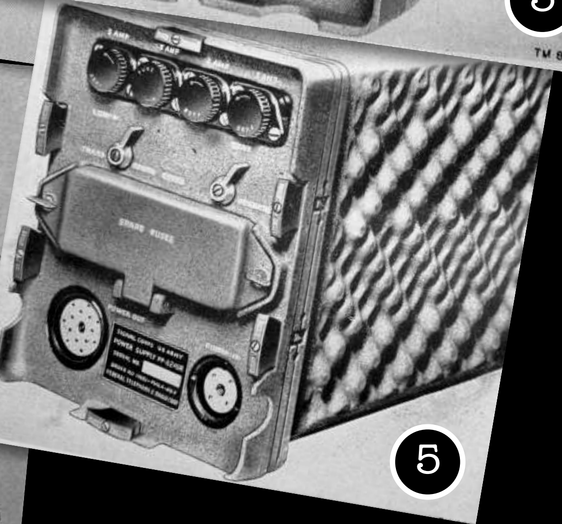
❾ The VRC-7 station

❿ The VRC-16 station

8
U
MOU
CAL CONTROL
-434/GRC
VOLUME
SQUELCH
AUDIO
POWER IN


7
MOUNTING PLATES
MOUNTING
CHANNELS
SURFACE PLATE
LOCKING
LEVERS
ABLE W-4
MPS
-6
SHOCK
MOUNTING
POWER
CABLE W-3
PLUG P-3
INT CONT
CABLE W-2
PLUG P-2
PLUG P-1
REC TR CONT
CABLE W-1
JUNCTION
BOX

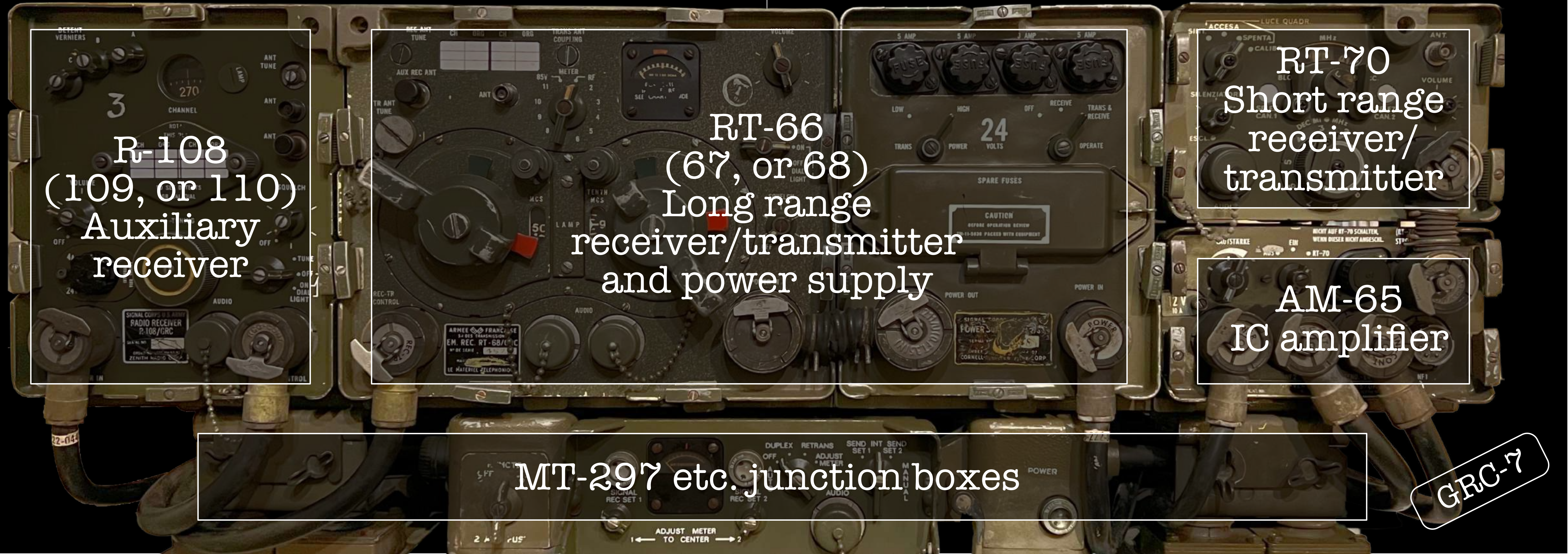

6
MOUNTING
CHANNELS
POWER IN
CABLE W-1
(AUX. REC.)
LOCKING
LEVERS
REC-CONT
CABLE W-2
REC-TR CONT
CABLE W-3
POWER IN
CABLE W-4
(SET 1)
TM 611-3



Trucks, tanks, artillery, infantry

Radio Sets AN/GRC-3, -4, -5, -6, -7, and -8, for example, were designed primarily for short-range operation within and between armoured, artillery, and infantry units.

They could be installed and operated in trucks, personnel carriers, tanks, armoured utility vehicles, weapons carriers, and other authorised vehicles. Specifically, Radio Sets AN/GRC-3 and -4 were intended for armoured use; AN/GRC-5 and -6 for the artillery, and AN/GRC-7 (mine in the photos) and -8 were for the infantry. Liaison between divisions was provided by Receiver-Transmitter RT-70/GRC (Set 2), which is common to all the radio sets. These Radio Sets were used primarily for short-range operation within and between armoured, artillery, and infantry units and provided FM radio-telephone facilities within the frequency range of 20.0 to 54.9 MHz, depending on the equipment configuration. The frequency coverage of each radio set included two bands. One band was covered by a Set 1 receiver-transmitter (RT-66/GRC, RT- 67/GRC, or RT-68/GRC). The other band was covered by the Set 2 receiver-transmitter (RT-70/GRC). In some GRC radio sets, the coverage of the Set 1 receiver-transmitter was duplicated by an auxiliary receiver (R-108/GRC, R-109/GRC, and R-110/GRC).

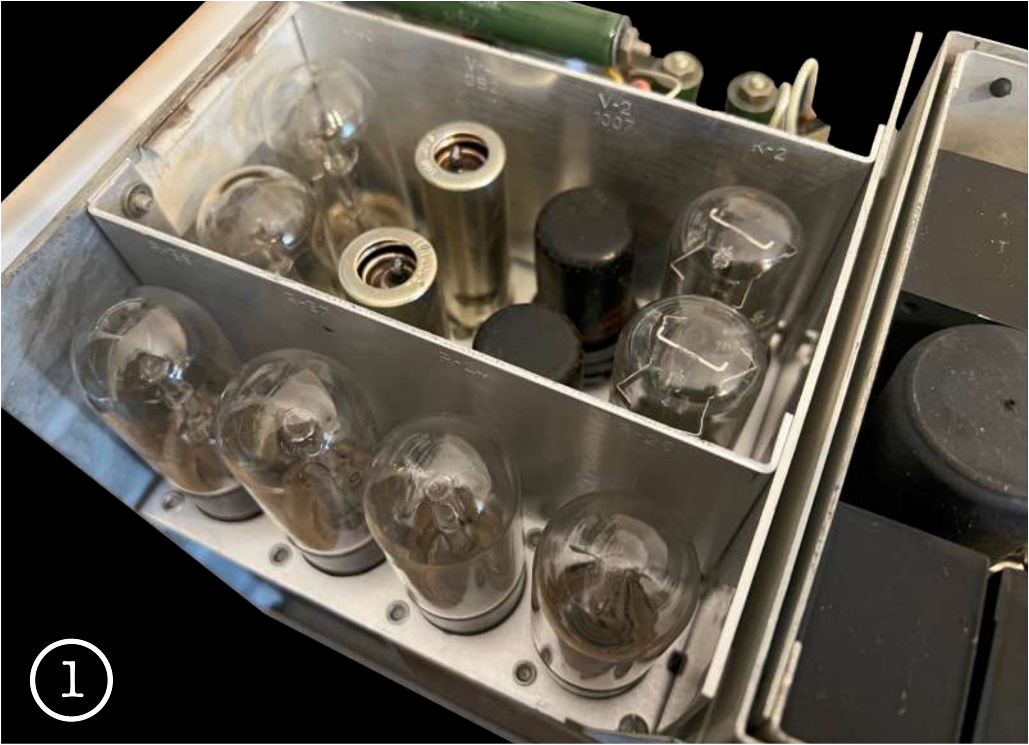

R-108
(109, or 110)
Auxiliary
receiver
RT-66
(67, or 68)
Long range
receiver/transmitter
and power supply
RT-70
Short range
receiver/
transmitter
AM-65
IC amplifier
MT-297 etc. junction boxes
GRC-7

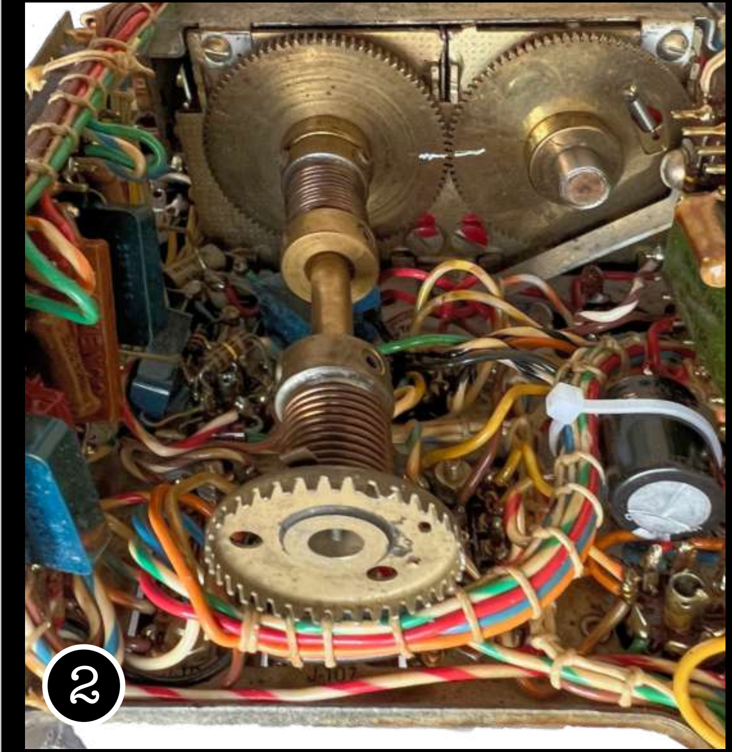
New concepts

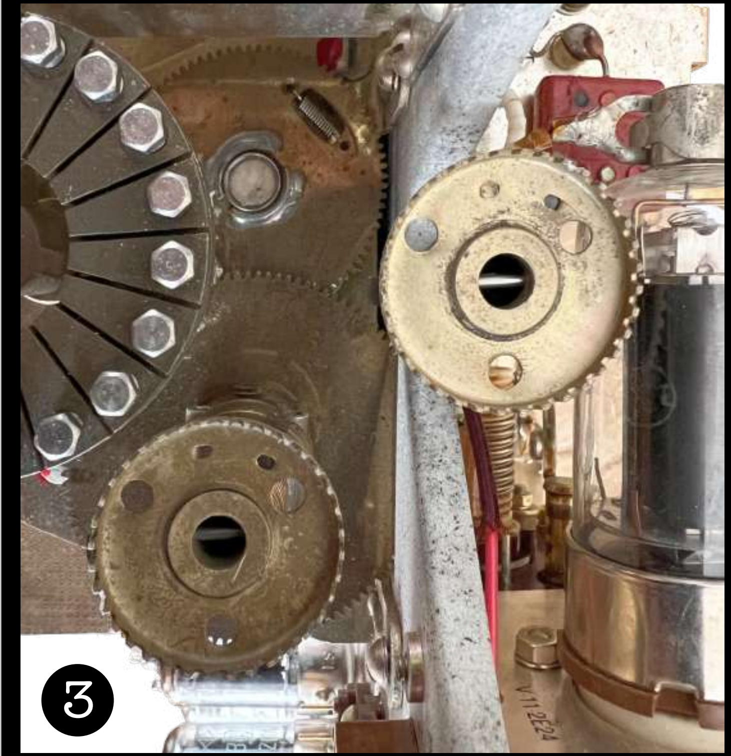
All the devices of this lucky series shared the same base technology, with miniature series vacuum tubes, perfectly married to a super-reliable mechanics, which allowed to arrive where that time electronics could not go. New trends were introduced:

- *the use of FM (frequency modulation) instead of AM, to get a better quality of the voice on short distances and allow a simpler construction of the modulator stage;*
- *the extreme ease of use. Nothing to fine-tune or referred to the diligence of the individual. Just select a channel, with two frequencies that could be stored in mechanical memories;*
- *different models for different bands and perhaps applications. In this way, you had not to include complex gears and circuits for the band change;*
- *water-proof design: even where the water was not a problem, this sealed approach ensured a greater reliability and an extra-long life.*

Looking at this equipment with today's concepts, the first question that comes to you is "how many workmanship hours were necessary to build such a monument? How could that cost?". Surely, they could not use a modern pick-and-place to assemble it. The quality was exceptional: in my RT-68, only few resistor changed their value after more than 60 years...







❶ Internals of PP-112 vibrator power supply of RT-6x receiver/transmitter. The six big lamps (bottom and left) are not normal vacuum tube but "ballast", something like a tungsten lamp, capable of regulating the current of the valve heaters. The two lamps on the right are instead thermal switches. When something went wrong in that current regulation, they could avoid a tube massacre due to filament overvoltage (but not always did...).

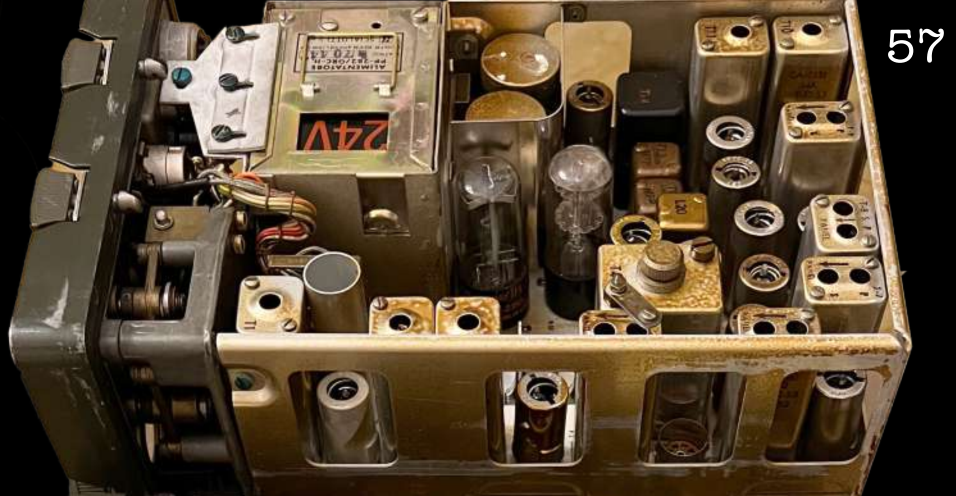
❷ details from an RT-70

❸ details from an RT-67

❹ RT-70 intermediate frequency chassis. The yellow color is due to the MFP anti-fungus coating.

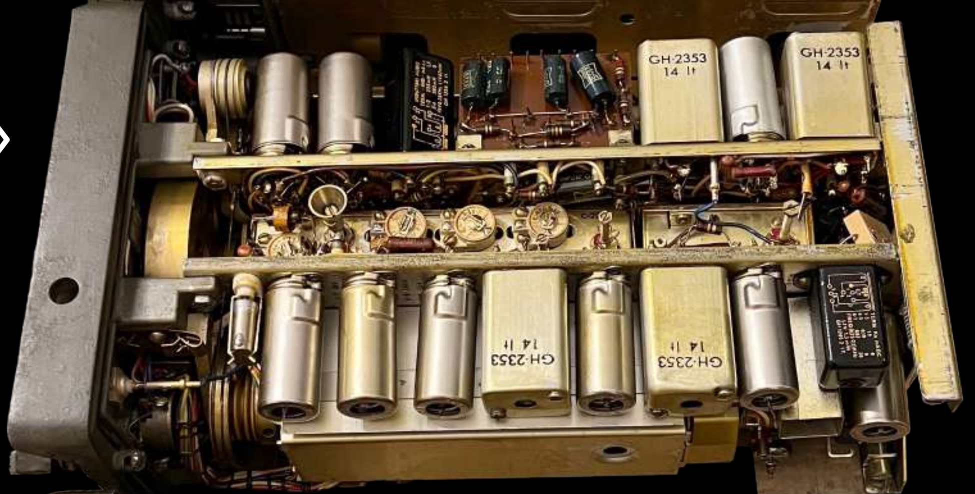
R-108(109,110)/GRC

An auxiliary receiver with its internal power supply. Two mechanical memories for preset frequencies.



RT-70/GRC

A very compact receiver/ transmitter from 40 to 54 MHz. Two mechanical memories for preset frequencies.

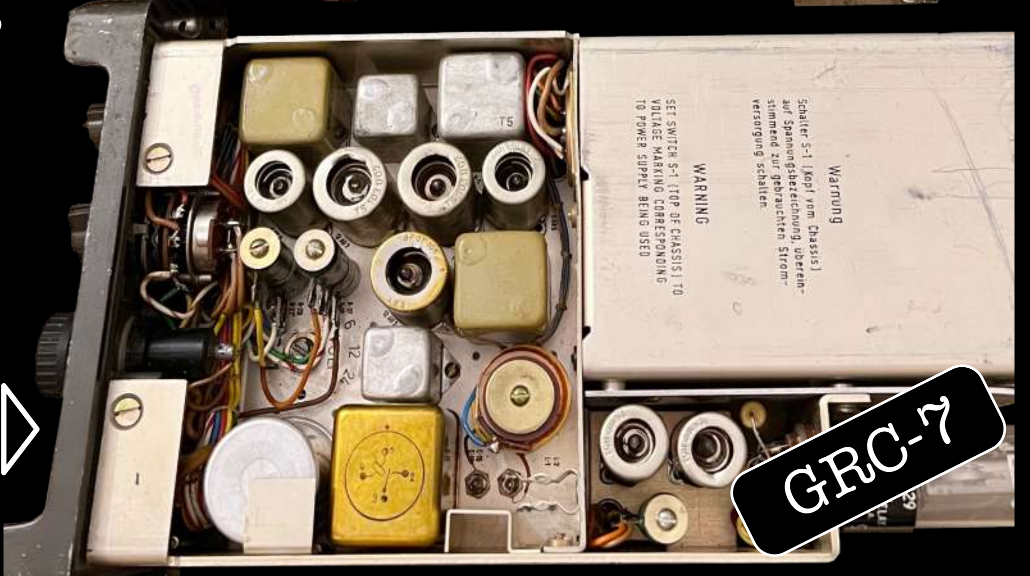

GH-2353 14 It
GH-2353 14 It

RT-66(67,68)/GRC

The main receiver/transmitter of the station. A superb mechanics to be very simple to use, even on a tank during a battle.

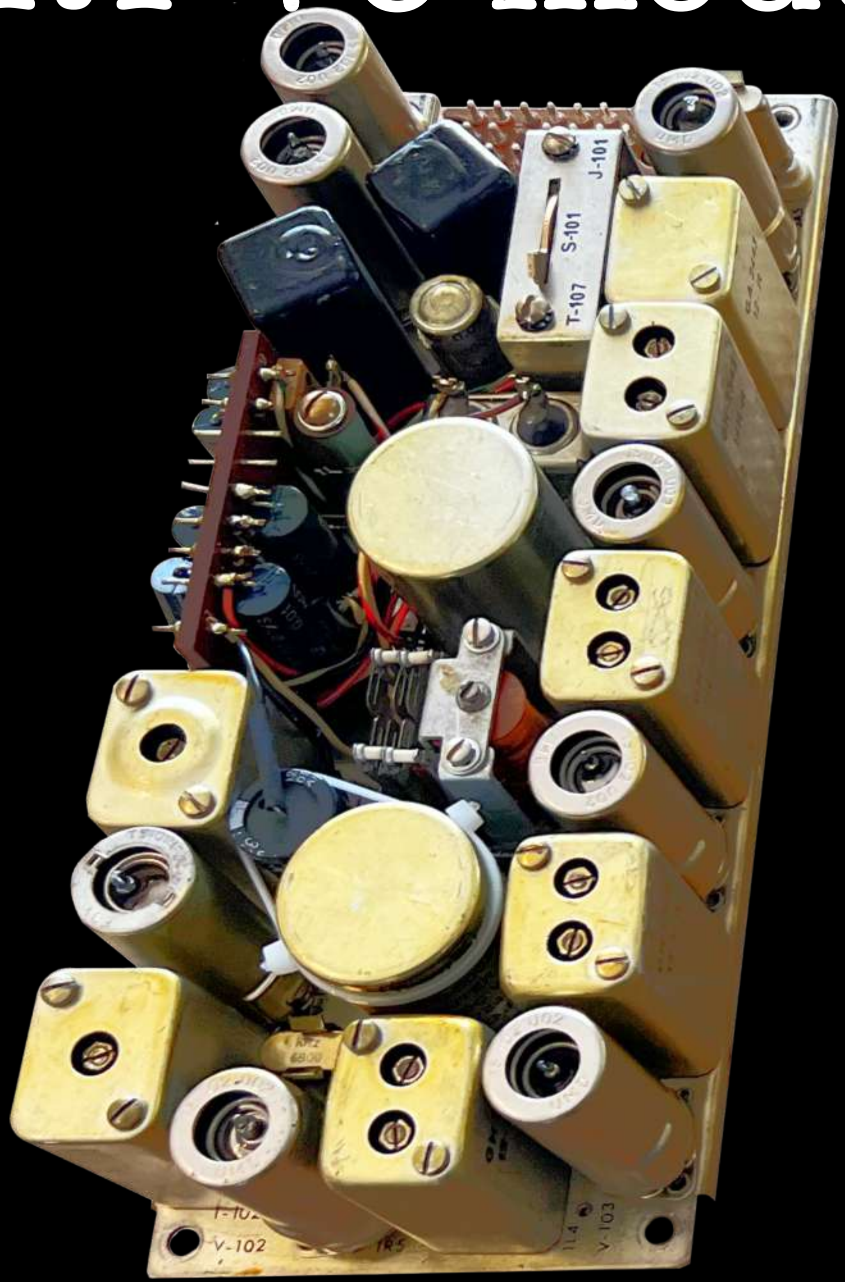
AM-65/GRC

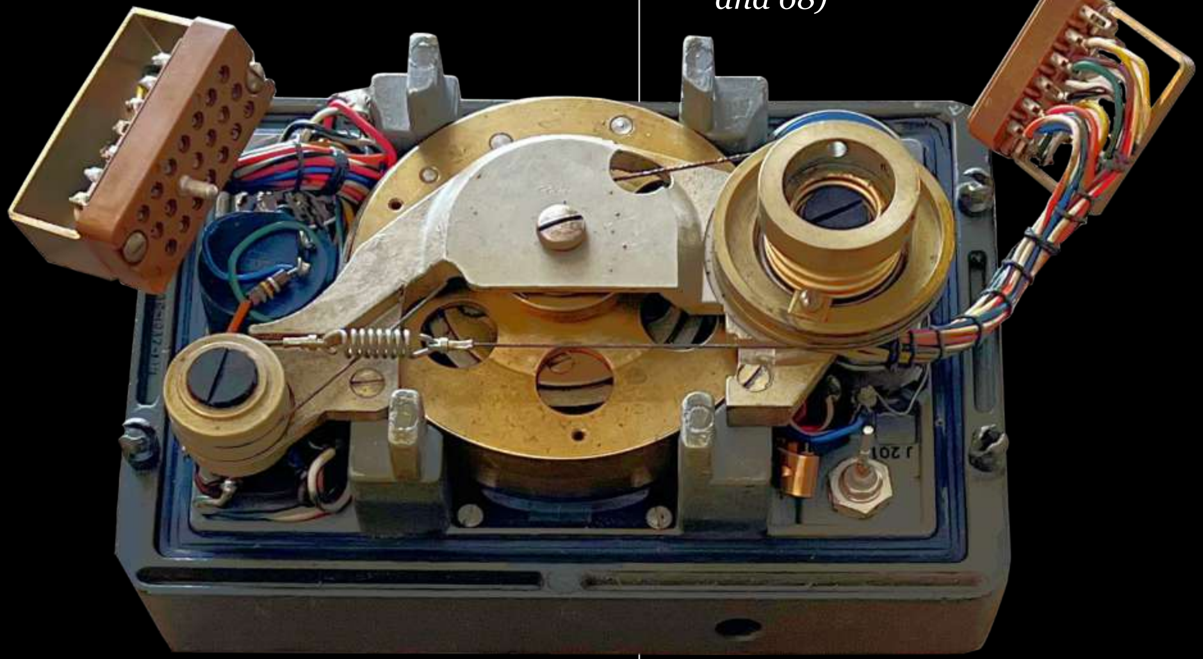
An audio amplifier for all the units composing the GRC-7 station. It includes the vibrator power supply for the RT-70.

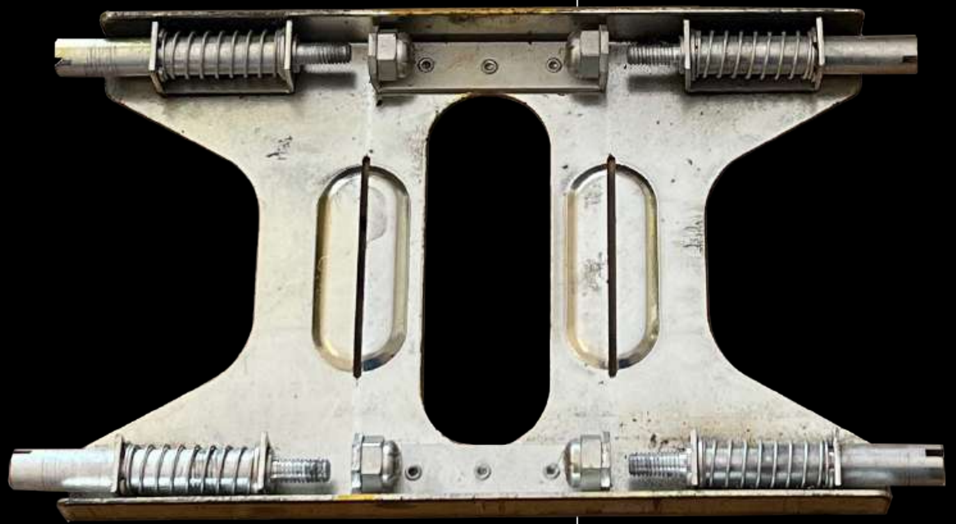

Warnung
WARNING
GRC-7

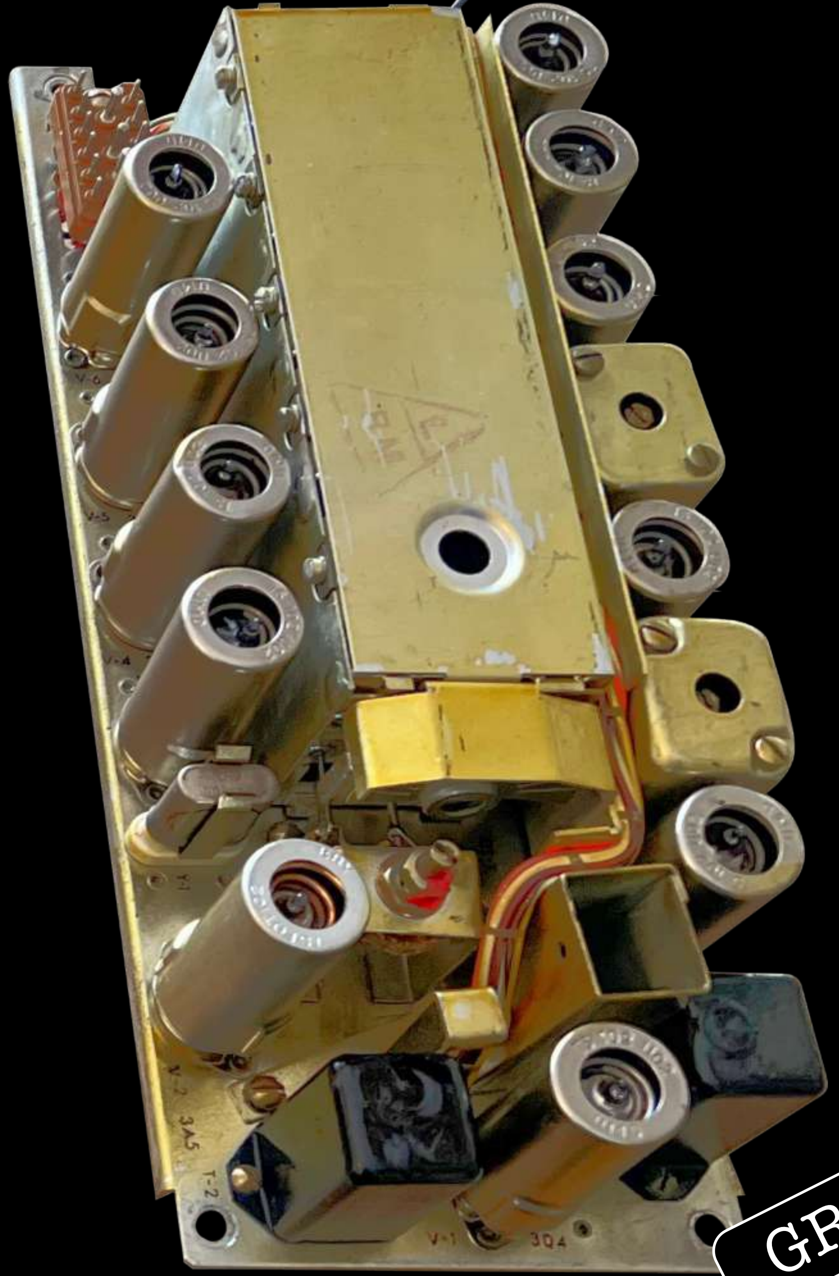
RT-70 modularity

In few minutes, RT-70/GRC can be split in parts like this. Note also how well the space is used to create an ultra-compact (for that time) receiver/transmitter and appreciate the quality of the mechanics and of the construction in general. The same approach had been followed for RT-66 (67 and 68)


J-101
S-101
T-107
V-102
V-103
1L4
1R5



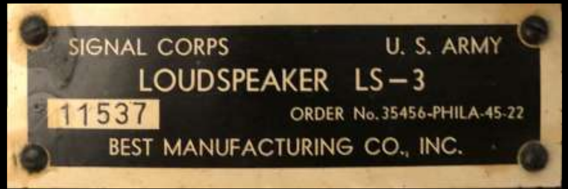


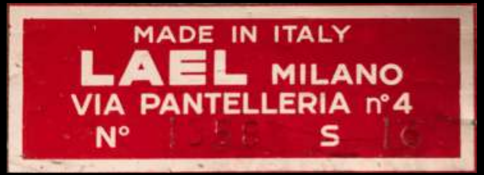

3A5
T-2
V-1
304

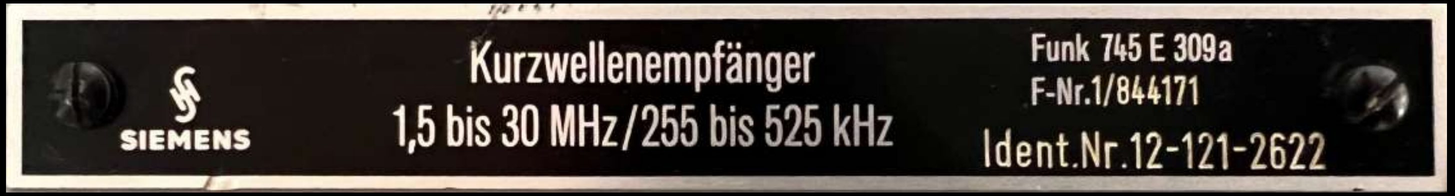
Wonderful labels!

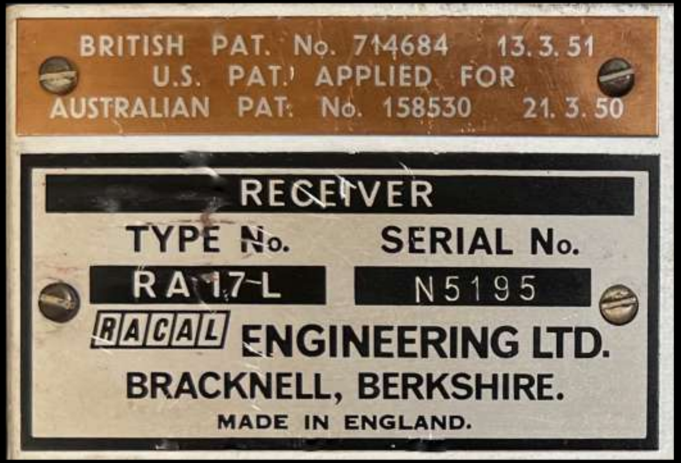
It's like the label of a bottle of good vintage wine: the label, that we normally find on each surplus device, makes it more valuable and often allows us to trace interesting information, such the manufacturer, the year of construction and more.

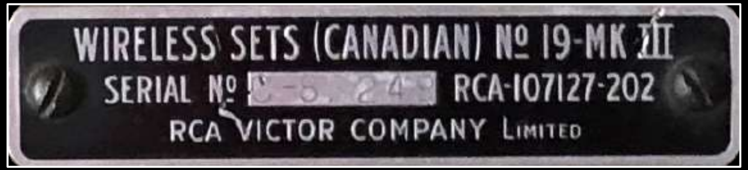
You can often find them on eBay, when the equipment you patiently restored is devoid of it.

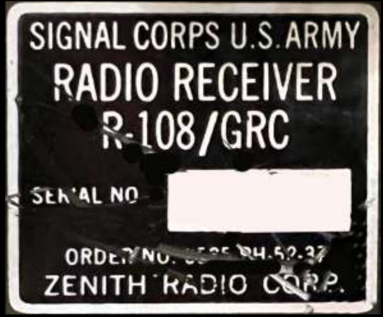

SIGNAL CORPS U. S. ARMY
LOUDSPEAKER LS–3
11537
ORDER No. 35456-PHILA-45-22
BEST MANUFACTURING CO., INC.

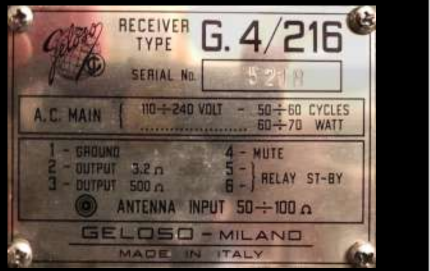

MADE IN ITALY
LAEL MILANO
VIA PANTELLERIA n°4
N°
S

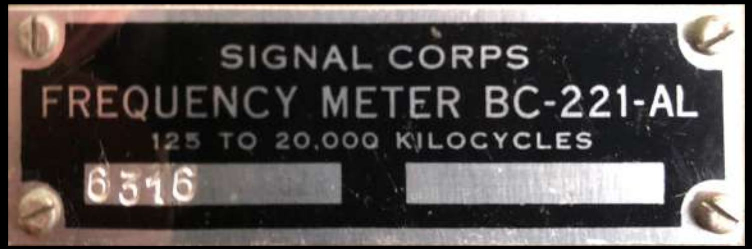

SIEMENS
Kurzwellenempfänger
1,5 bis 30 MHz/255 bis 525 kHz
Funk 745 E 309a
F-Nr.1/844171
Ident.Nr.12-121-2622

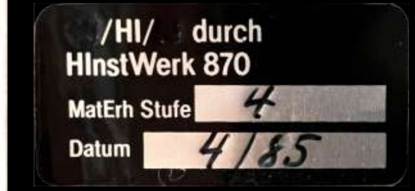

BRITISH PAT. No. 714684 13.3.51
U.S. PAT. APPLIED FOR
AUSTRALIAN PAT. No. 158530 21.3.50
RECEIVER
TYPE No.
SERIAL No.
RA 17-L
N5195
RACAL ENGINEERING LTD.
BRACKNELL, BERKSHIRE.
MADE IN ENGLAND.

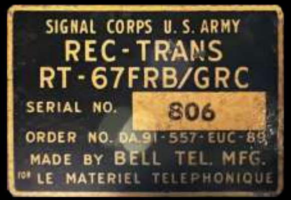

WIRELESS SETS (CANADIAN) № 19-MK III
SERIAL №
RCA-107127-202
RCA VICTOR COMPANY LIMITED

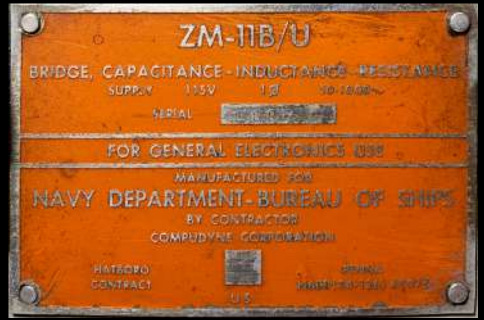

SIGNAL CORPS U.S. ARMY
RADIO RECEIVER
R-108/GRC
SERIAL NO
ORDER NO.
ZENITH RADIO CORP.

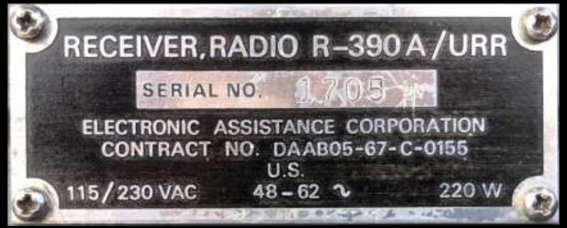

RECEIVER TYPE
G. 4/216
SERIAL No.
A.C. MAIN
110÷240 VOLT
50÷60 CYCLES
60÷70 WATT
1 - GROUND
2 - OUTPUT 3.2 Ω
3 - OUTPUT 500 Ω
4 - MUTE
5 - RELAY ST-BY
6 -
ANTENNA INPUT 50÷100 Ω
GELOSO - MILANO
MADE IN ITALY

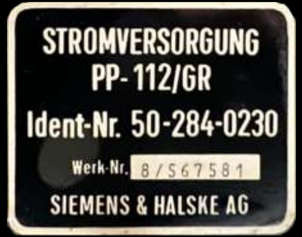

SIGNAL CORPS
FREQUENCY METER BC-221-AL
125 TO 20,000 KILOCYCLES
6316

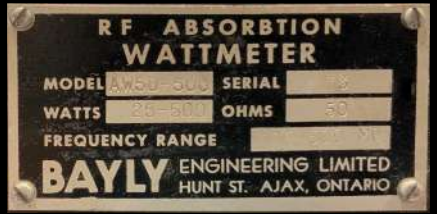

/HI/ durch
HInstWerk 870
MatErh Stufe 4
Datum 4/85

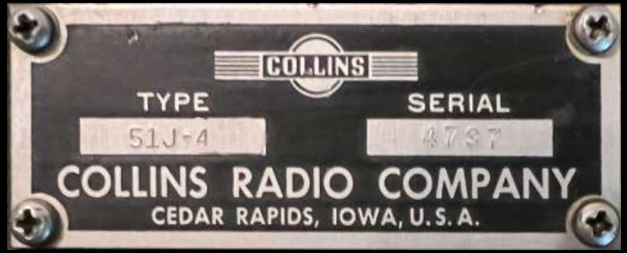

SIGNAL CORPS U. S. ARMY
REC-TRANS
RT-67FRB/GRC
SERIAL NO. 806
ORDER NO. DA 91-557-EUC-89
MADE BY BELL TEL. MFG.
FOR LE MATERIEL TELEPHONIQUE

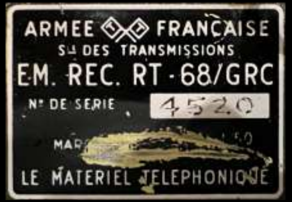

ZM-11B/U
BRIDGE, CAPACITANCE-INDUCTANCE-RESISTANCE
SERIAL
FOR GENERAL ELECTRONICS USE
MANUFACTURED FOR
NAVY DEPARTMENT-BUREAU OF SHIPS
BY CONTRACTOR
COMPUDYNE CORPORATION
HATBORO
CONTRACT
U.S.

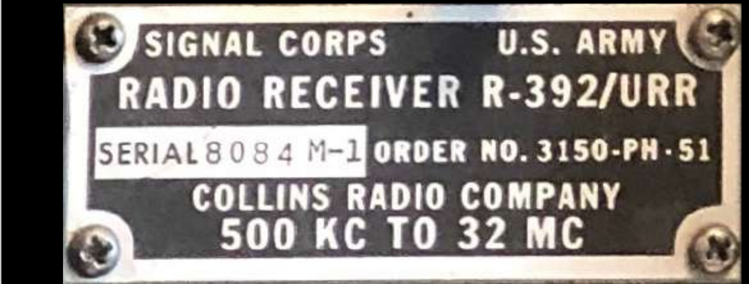

RECEIVER, RADIO R-390A/URR
SERIAL NO. 1705
ELECTRONIC ASSISTANCE CORPORATION
CONTRACT NO. DAAB05-67-C-0155
U.S.
115/230 VAC
48 – 62 ∿
220 W

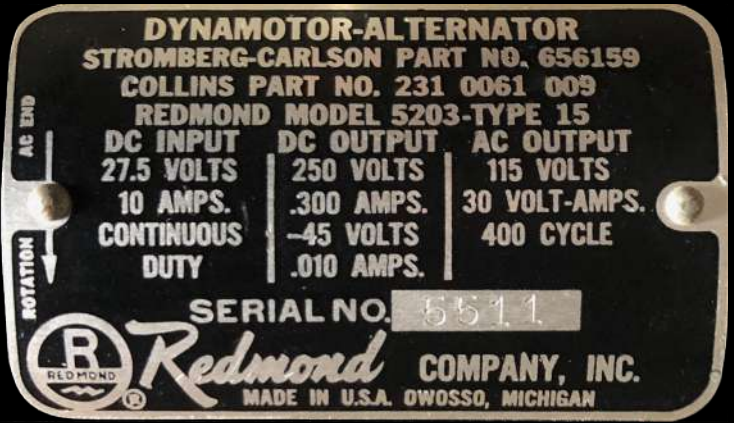

STROMVERSORGUNG
PP-112/GR
Ident-Nr. 50-284-0230
Werk-Nr. 8/567581
SIEMENS & HALSKE AG

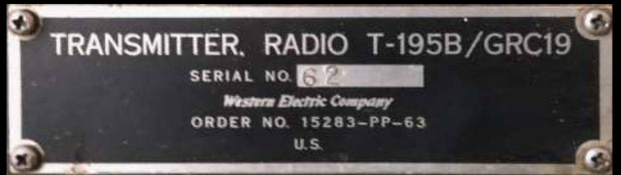

RF ABSORBTION
WATTMETER
MODEL
SERIAL
WATTS
OHMS 50
FREQUENCY RANGE
BAYLY ENGINEERING LIMITED
HUNT ST. AJAX, ONTARIO

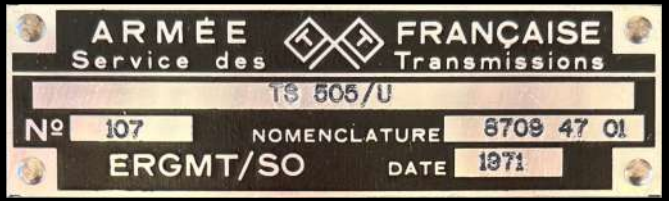

COLLINS
TYPE
SERIAL
51J-4
COLLINS RADIO COMPANY
CEDAR RAPIDS, IOWA, U.S.A.

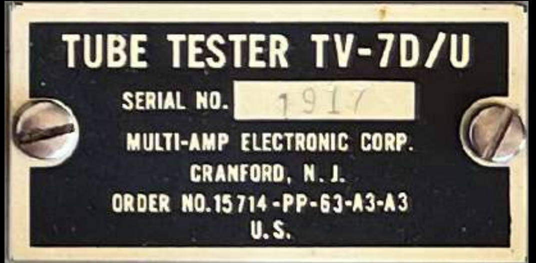

ARMEE FRANÇAISE
Sce DES TRANSMISSIONS
EM. REC. RT-68/GRC
N° DE SERIE 4520
LE MATERIEL TELEPHONIQUE


SIGNAL CORPS U.S. ARMY
RADIO RECEIVER R-392/URR
SERIAL 8084 M-1
ORDER NO. 3150-PH-51
COLLINS RADIO COMPANY
500 KC TO 32 MC


DYNAMOTOR-ALTERNATOR
STROMBERG-CARLSON PART NO. 656159
COLLINS PART NO. 231 0061 009
REDMOND MODEL 5203-TYPE 15
DC INPUT
27.5 VOLTS
10 AMPS.
CONTINUOUS DUTY
DC OUTPUT
250 VOLTS
.300 AMPS.
-45 VOLTS
.010 AMPS.
AC OUTPUT
115 VOLTS
30 VOLT-AMPS.
400 CYCLE
AC END
ROTATION
SERIAL NO. 5511
REDMOND
Redmond COMPANY, INC.
MADE IN U.S.A. OWOSSO, MICHIGAN


TRANSMITTER, RADIO T-195B/GRC19
SERIAL NO.
Western Electric Company
ORDER NO. 15283-PP-63
U.S.


ARMÉE FRANÇAISE
Service des Transmissions
TS 505/U
N° 107
NOMENCLATURE 8709 47 01
ERGMT/SO
DATE 1971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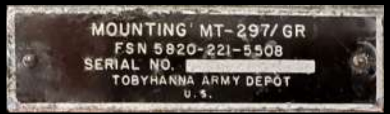
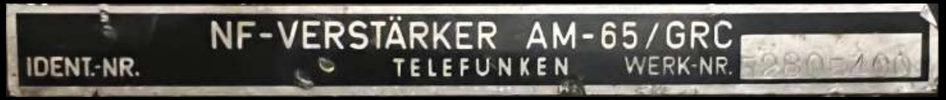
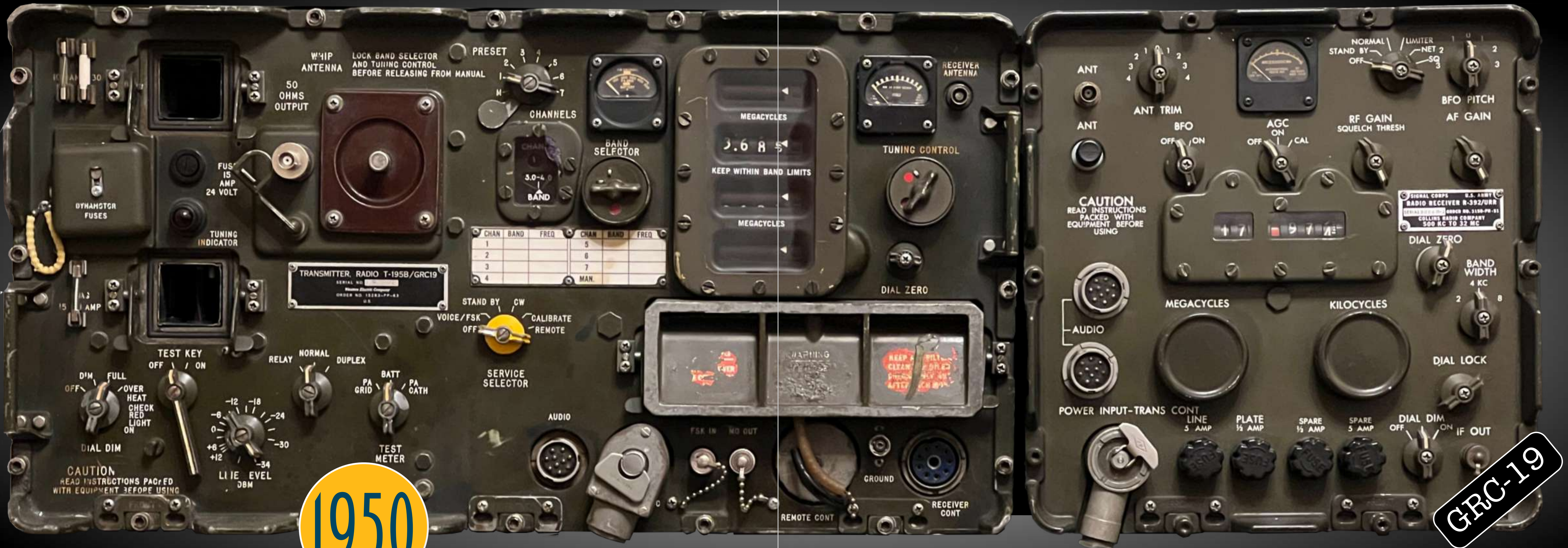
MULTI-AMP ELECTRONIC CORP.
CRANFORD, N. J.
ORDER NO. 15714-PP-63-A3-A3
U.S.


MOUNTING MT-297/GR
FSN 5820-221-5508
SERIAL NO.
TOBYHANNA ARMY DEPOT
U.S.


NF-VERSTÄRKER AM-65/GRC
IDENT.-NR.
TELEFUNKEN
WERK-NR.

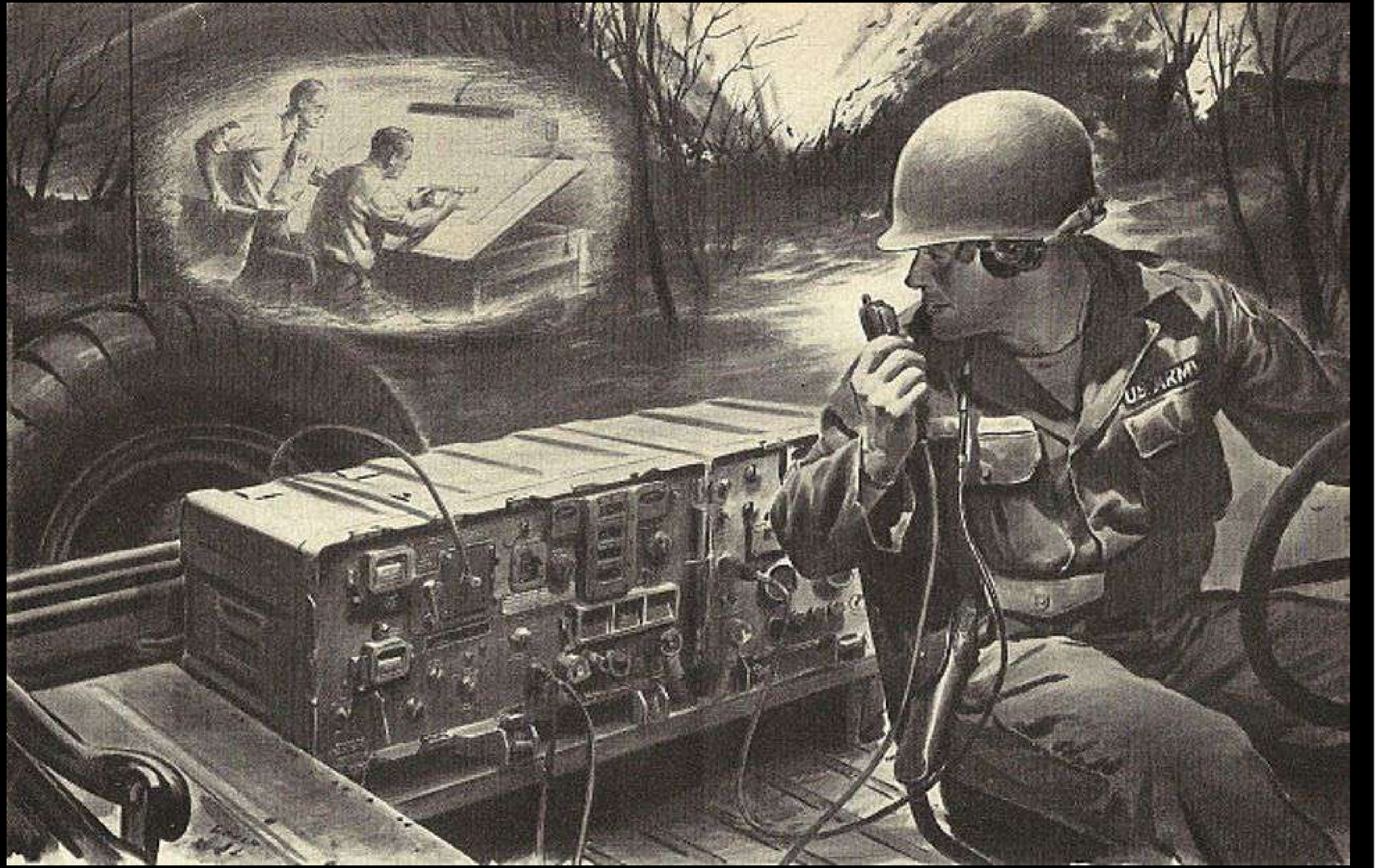

WHIP ANTENNA
50 OHMS OUTPUT
LOCK BAND SELECTOR AND TUNING CONTROL BEFORE RELEASING FROM MANUAL
PRESET
CHANNELS
BAND SELECTOR
MEGACYCLES
KEEP WITHIN BAND LIMITS
RECEIVER ANTENNA
TUNING CONTROL
DIAL ZERO
DYNAMOTOR FUSES
FUSE 15 AMP 24 VOLT
TUNING INDICATOR
TRANSMITTER, RADIO T-195B/GRC19
CHAN BAND FREQ
MAN.
STAND BY
CW
VOICE/FSK
OFF
CALIBRATE
REMOTE
SERVICE SELECTOR
TEST KEY
OFF
ON
DIM
FULL
OFF
OVER HEAT
CHECK RED LIGHT
ON
DIAL DIM
RELAY
NORMAL
DUPLEX
BATT
PA GRID
PA CATH
TEST METER
LINE LEVEL DBM
CAUTION
READ INSTRUCTIONS PACKED WITH EQUIPMENT BEFORE USING
AUDIO
FSK IN
MO OUT
GROUND
REMOTE CONT
RECEIVER CONT
ANT
ANT TRIM
BFO
AGC
CAL
NORMAL
STAND BY
OFF
LIMITER
NET
SQ
BFO PITCH
AF GAIN
RF GAIN
SQUELCH THRESH
CAUTION
READ INSTRUCTIONS PACKED WITH EQUIPMENT BEFORE USING
RADIO RECEIVER R-392/URR
COLLINS RADIO COMPANY
500 KC TO 32 MC
DIAL ZERO
BAND WIDTH
KC
MEGACYCLES
KILOCYCLES
AUDIO
DIAL LOCK
POWER INPUT-TRANS CONT
LINE 5 AMP
PLATE ½ AMP
SPARE ½ AMP
SPARE 5 AMP
DIAL DIM
OFF
ON
IF OUT

1950

GRC-19

Non plus ultra

Around 1951, with the Korean war starting up, the U.S. Army needed to update its portable communications equipment (BC-610, BC-191, BC-669, BC-342-344 etc.), with a new transmitter-receiver of modern design, operated at a moderate power level, usable outdoors or even deployed via parachute. The result was the GRC-19, with the T-195 transmitter and the R-392 receiver. Among the equipment I know, AN/GRC-19 is definitely the absolute top of vacuum tube technology. It takes up the concepts already developed for the R-390/URR receiver and some of the AN/ART-13 transmitter, to create the for me most wonderful unit in the post-war panorama.



GRC-19 concepts

The GRC-19 had to be portable, so it was designed to operate exclusively on +24V DC to +28V DC and the entire system had to be somewhat "weather proof." To allow the receiver to be completely sealed with no ventilation and thus, to have the receiver run as cool as possible, no voltages higher than +28V DC are used in the R-392. The T-195 transmitter used forced-air cooling for the three external-anode tubes used in the PA and Modulator so an oil dampened air filter was provided for the intake but this did not "water proof" the transmitter while it was in operation. It was possible to seal the intake and exhaust ports when the transmitter was not in use to aid in the weather-proofing. Additionally, many times the military was going to have to "drop" communications gear from the air, so the R-392 and T-195 had to be "ruggedised" to be able to survive this type of deployment for portable field use. The air-drops were usually fully-equipped Jeeps. Fred Johnson, Collins' head mechanical design engineer for the T-195, indicated that one of the "endurance tests" for the T-195 design was for its survival of a drop from twenty feet [7.6 meters] - impressive!

The GRC-19 was commonly used on Jeep-type vehicles up to larger "command car" types. A whip antenna was used if operation was going to be mobile but, if the vehicle was going to be parked in one location for longer than an hour and a half, a dipole antenna was usually erected since power output was much better with this type of antenna.

The GRC-19 was capable of FSK transmission and could be set up to operate portable RTTY. This required an external FSK unit that connected to the MO OUT and the FSK IN connectors on the T-195 transmitter. It was also necessary to use a RTTY TU connected to the R-392 IF OUTPUT to operate the RTTY printer. Most of the RTTY uses seem to be early in the GRC-19's history and the mode isn't even mentioned in later manuals (by the 1960s.)

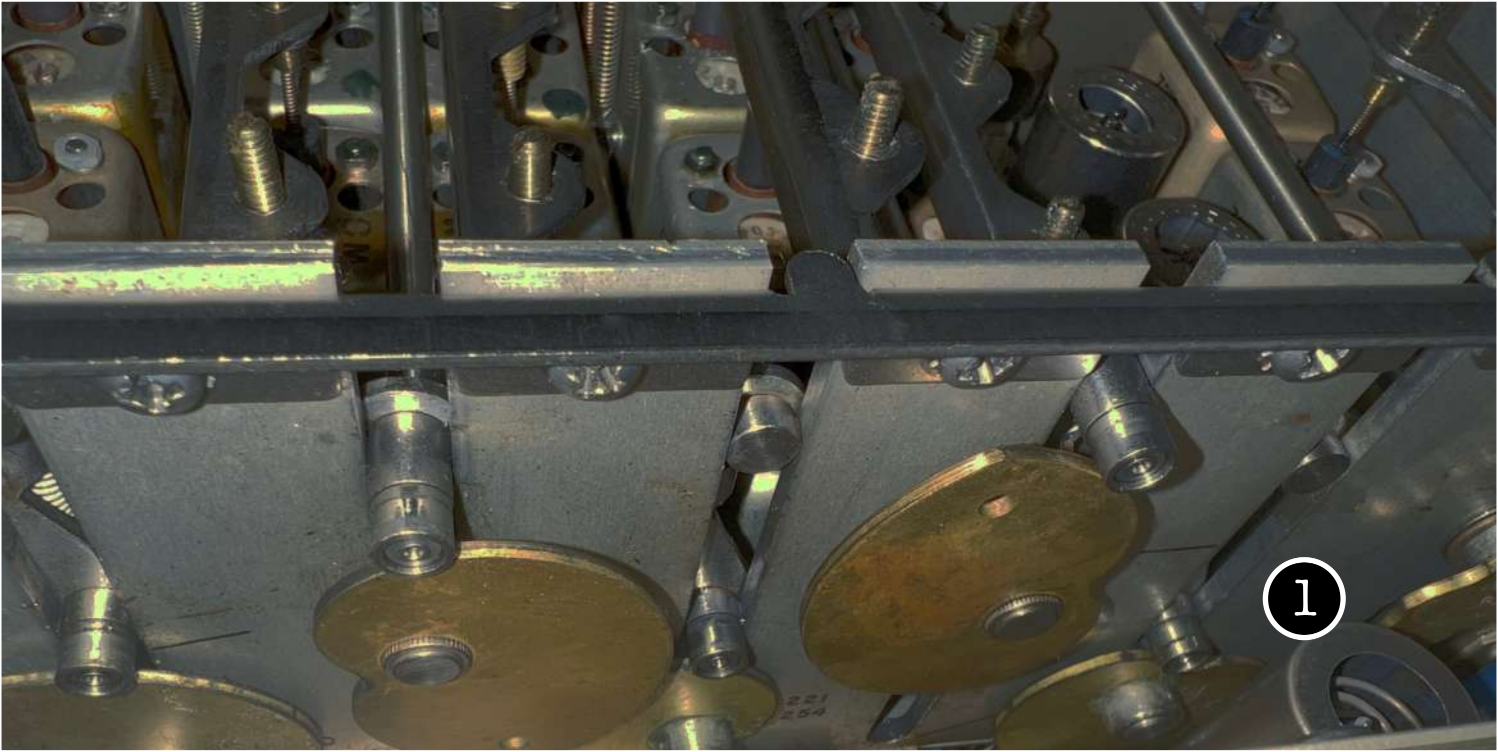
(from Radio Boulevard - Western Historic Radio Museum where you can find the best description of this equipment and super-valuable notes on its restoration)

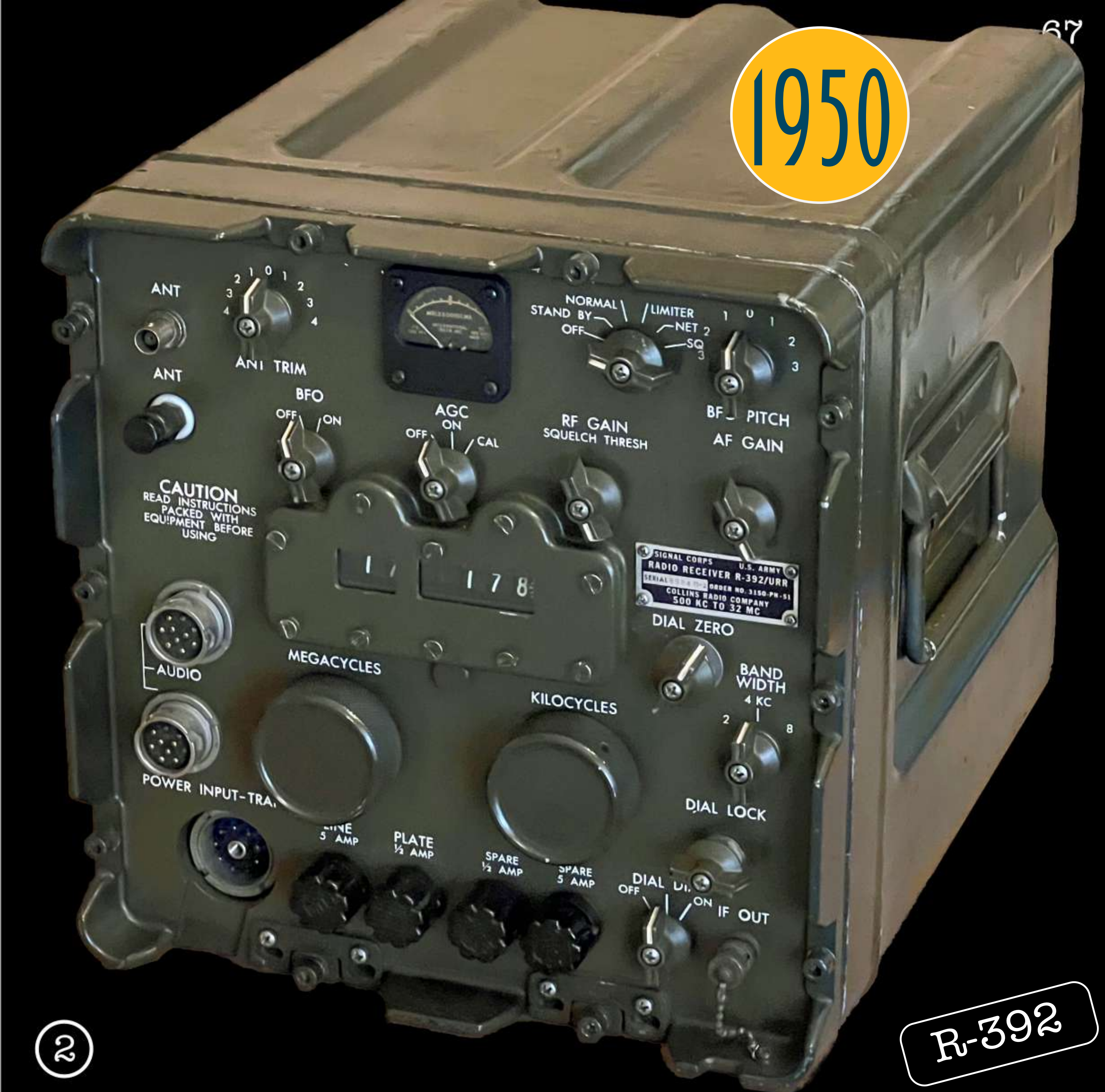
R-392/URR receiver

We spoke about T-195 transmitter, but we must not to forget the second half of GRC-19, the small, beautiful and ultra technological R-392/URR receiver. In it, we can rediscover most of the features of its big brother R-390(A), except the mythical mechanical filters. But that in about one half of the volume, with only 28V plate voltage, to be used on vehicles, and with the capability to operate even if submerged in water! Today, we could say that it has an IP67 protection degree, that seems incredible with all those knobs and connectors. Furthermore, is sufficiently rugged to withstand parachute delivery, as we said.

It was designed by the Collins Radio Co. and, like the R-390(A), produced by Collins and other manufacturers on several contracts from 1950 to 1963. Thanks to the hermetic sealing and the exceptional quality, most of the units are internally still like new.

In the photo below: the base technology of the digital display is the some adopted in R-390(A), and, again, the linearization of the tuning is performed by using cams.


①


1950

ANT
ANT TRIM
ANT
BFO
OFF
ON
AGC
ON
OFF
CAL
NORMAL
STAND BY
OFF
LIMITER
NET
SQ
RF GAIN
SQUELCH THRESH
BF
PITCH
AF GAIN
CAUTION
READ INSTRUCTIONS PACKED WITH EQUIPMENT BEFORE USING
SIGNAL CORPS U.S. ARMY
RADIO RECEIVER R-392/URR
COLLINS RADIO COMPANY
500 KC TO 32 MC
DIAL ZERO
AUDIO
MEGACYCLES
KILOCYCLES
BAND WIDTH
4 KC
2
8
POWER INPUT-TRA
DIAL LOCK
PLATE ½ AMP
SPARE ½ AMP
SPARE 5 AMP
DIAL
OFF
ON
IF OUT

②

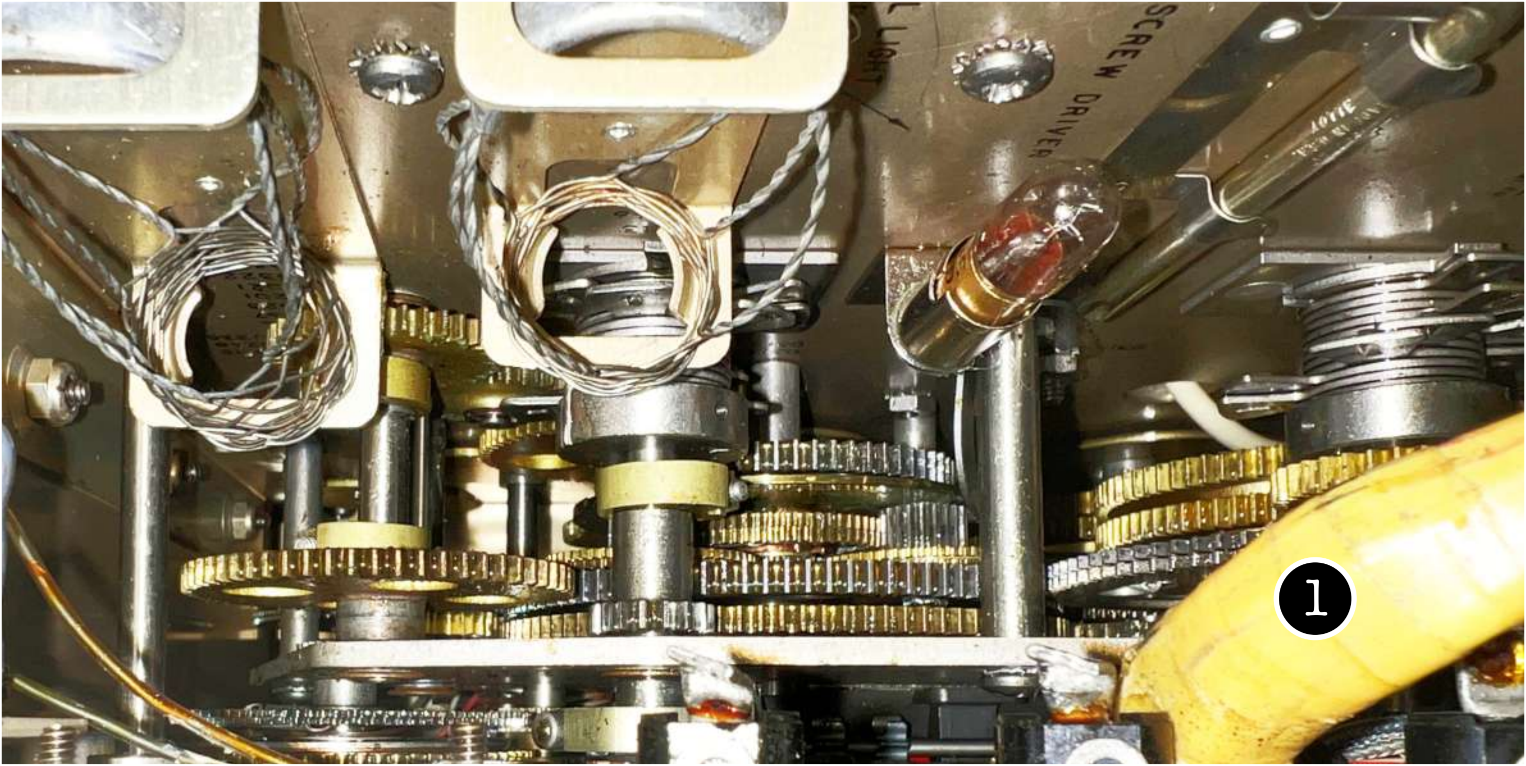
R-392

Full immersion

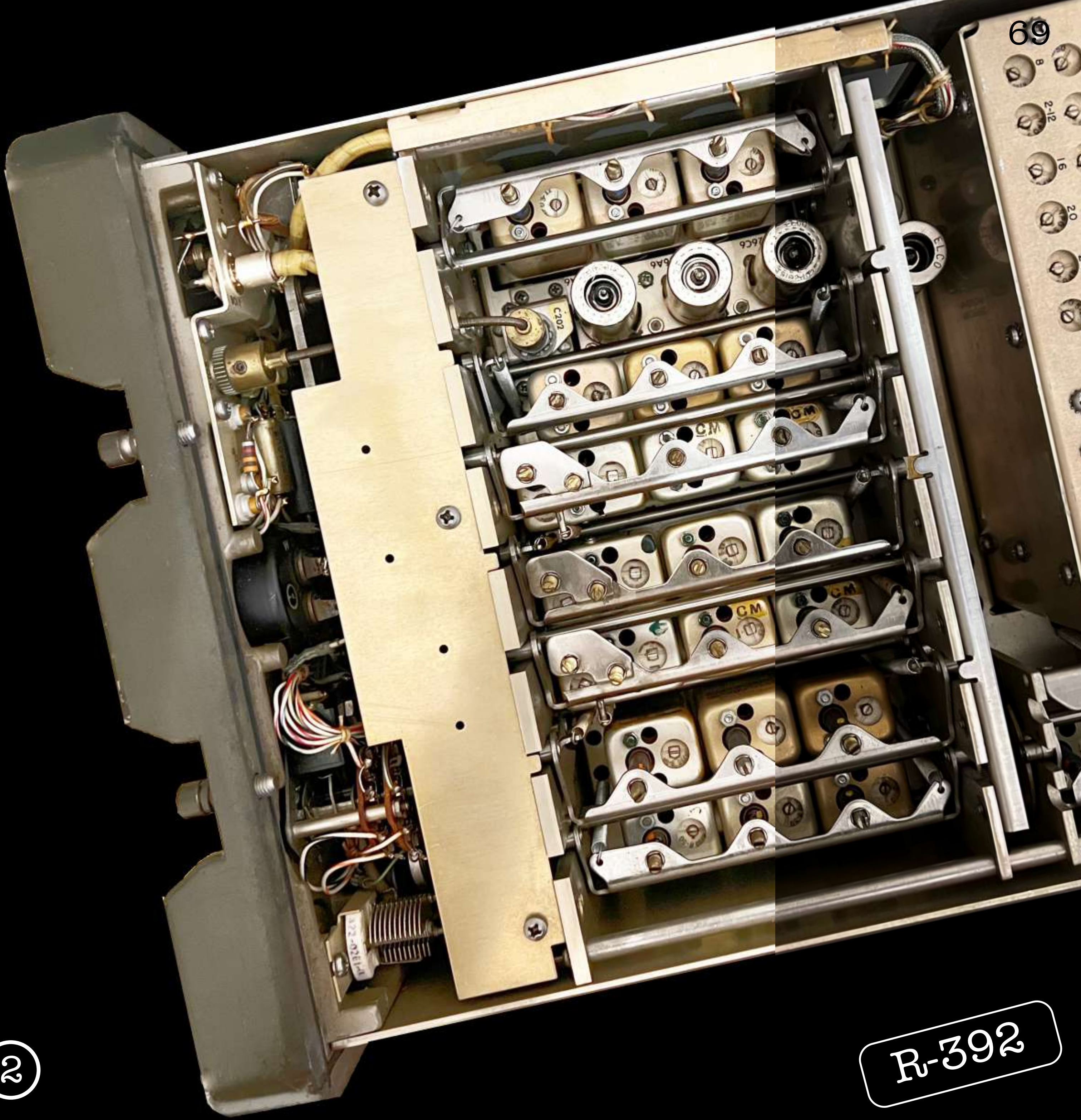
According to the manual, “Radio Receiver R-392/URR (fig. 1) is a high-performance, compact, rugged receiver designed primarily for vehicular use. The receiver provides reception of radiotelegraph, voice, and single-channel, frequency-shift radioteletype signals within a continuous frequency range from 500 kilocycles (kc) to 32 megacycles (mc). The receiver is immersion-proof and is sufficiently rugged to withstand parachute delivery when mounted in a 1⁄4-ton, 4 x 4 truck prepared for parachute drop, or in a standard type of U. S. Army parachute delivery container.”

R-392 has 25 tubes, has a temperature range from -40°C to 65°C and weights 23,6 kg (52 lb.). These figures are not met still today by most of the modern equipment.

❶ In this photo you can see not only the beautiful gear but also the set of accessories contained in the housing: two tube pullers (today extremely valuable!), a spare lamp and an angled screwdriver. ❷ My R-392 seems to be new: maybe that it has never been put in real operation. Here you can see the upper deck. The modules are the RF Module that has all of the RF transformers, the tuning slug racks and slugs along with the variable IF transformers and its slug racks and slugs. The module the has all of the trimmers is the Crystal Oscillator module. Although reduced in size, these modules are very similar to the R-390/URR receiver.

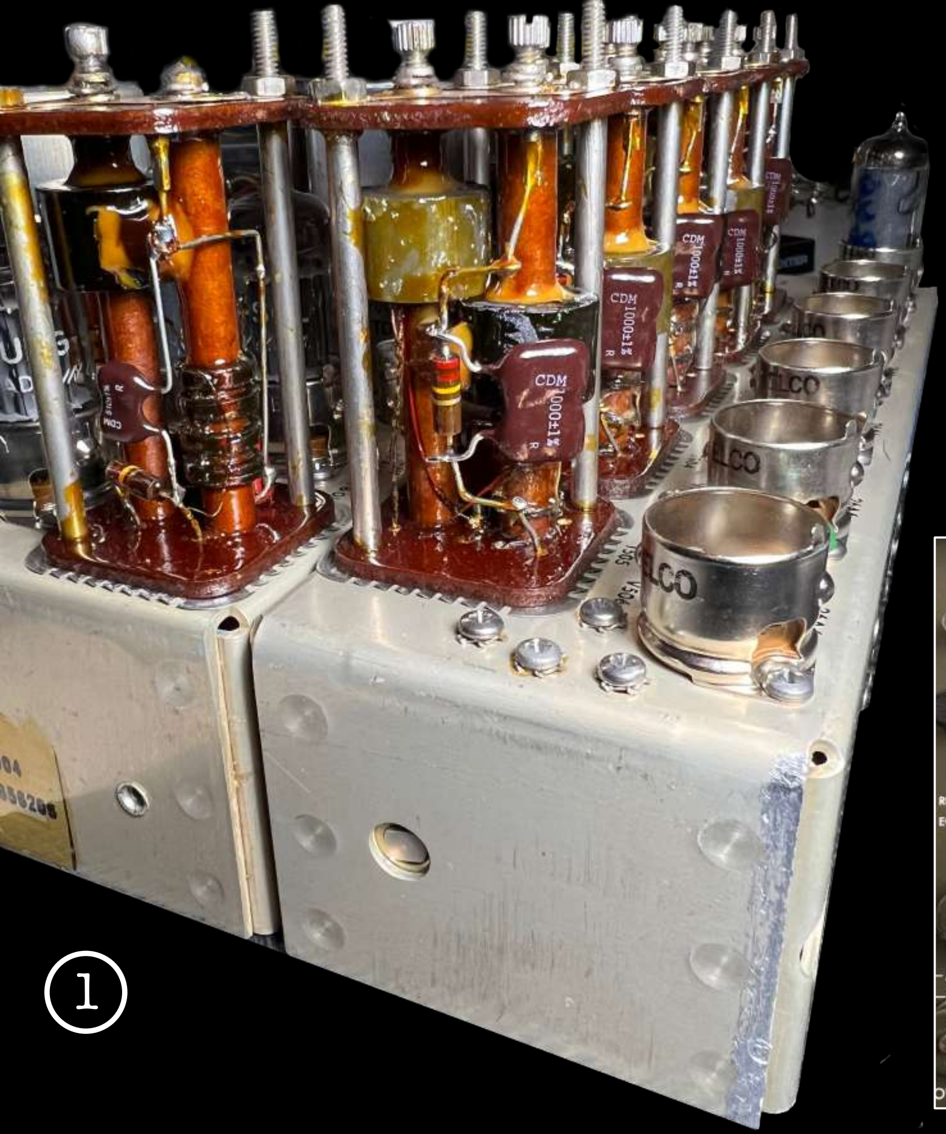


1



2

Six IF stages

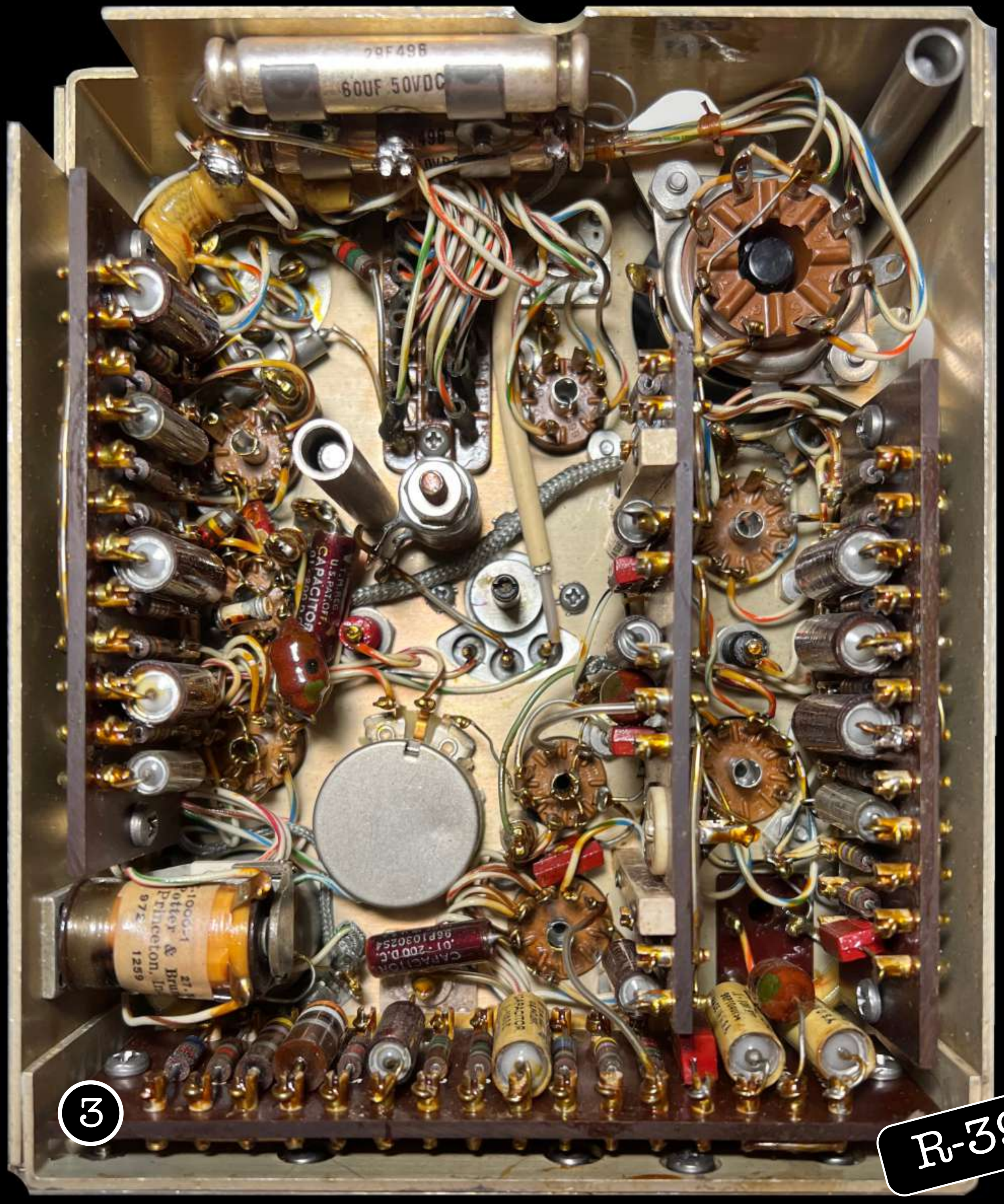

①
CDM
CDM
CDM
ELCO

❶ The IF transformers without the metal screens show the replaced mica capacitors (the ones with "CDM" mark). After 70+ years (my unit is from 1951), some of the originals were no longer good. Also several resistors had to be replaced, having changed their original value.

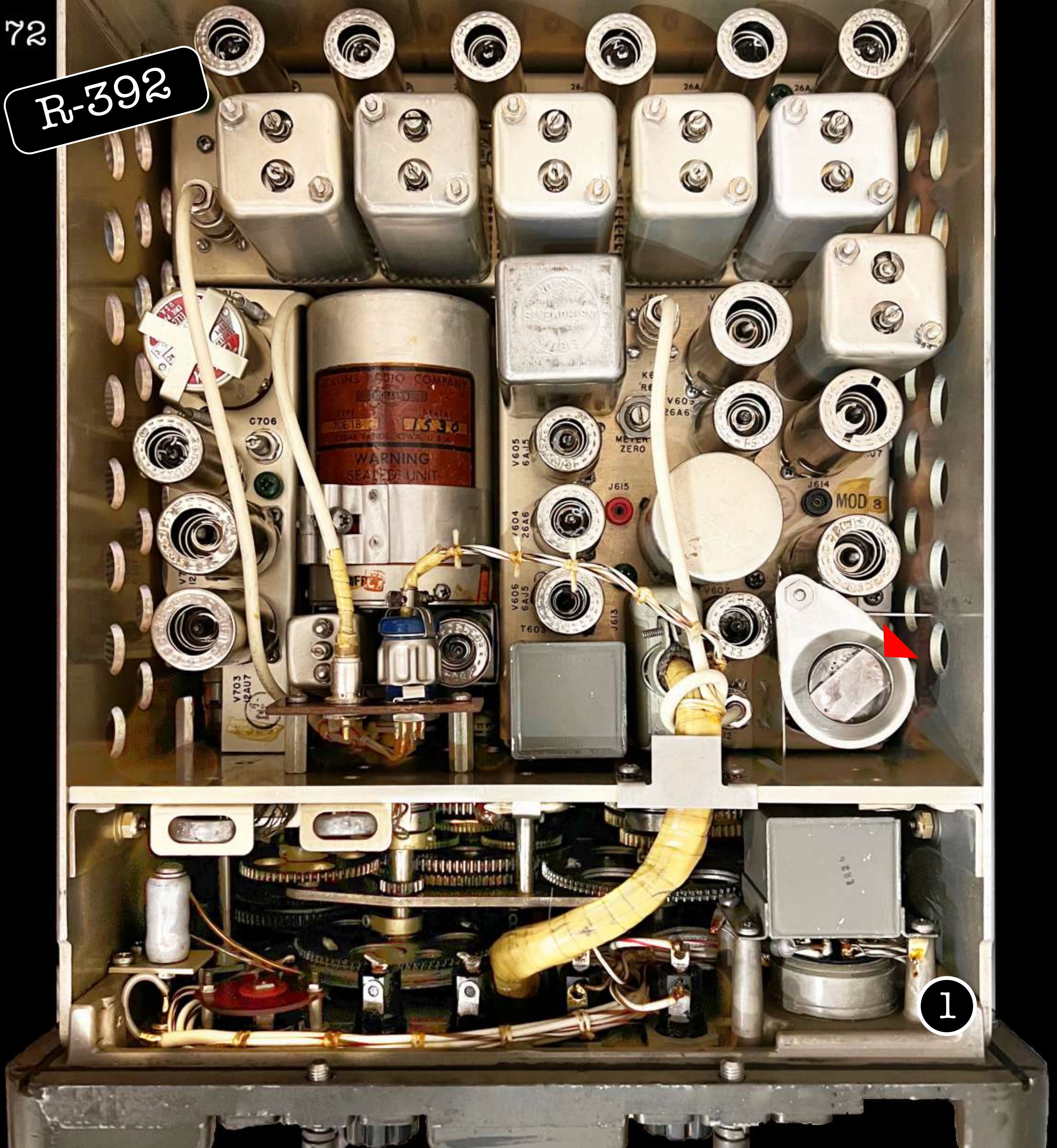
❷ You can guess that the R-392 can withstand to water by the high number of screws that fix the display cover. Every knob has an associated sealing system behind to allow operation in the water.

❸ the audio frequency chassis, seen from bottom. The electrolytic capacitors were in good conditions but had lost part of their value.

②
ANT
ANT TRIM
ANT
BFO
OFF ON
AGC
ON
OFF CAL
RF GAIN
SQUELCH THRESH
NORMAL
STAND BY
OFF
LIMITER
NET
CAUTION
READ INSTRUCTIONS PACKED WITH EQUIPMENT BEFORE USING
0 7
0 6 7
DIAL ZERO
MEGACYCLES
KILOCYCLES
AUDIO
DIAL LOCK


③
60UF 50VDC
CAPACITOR

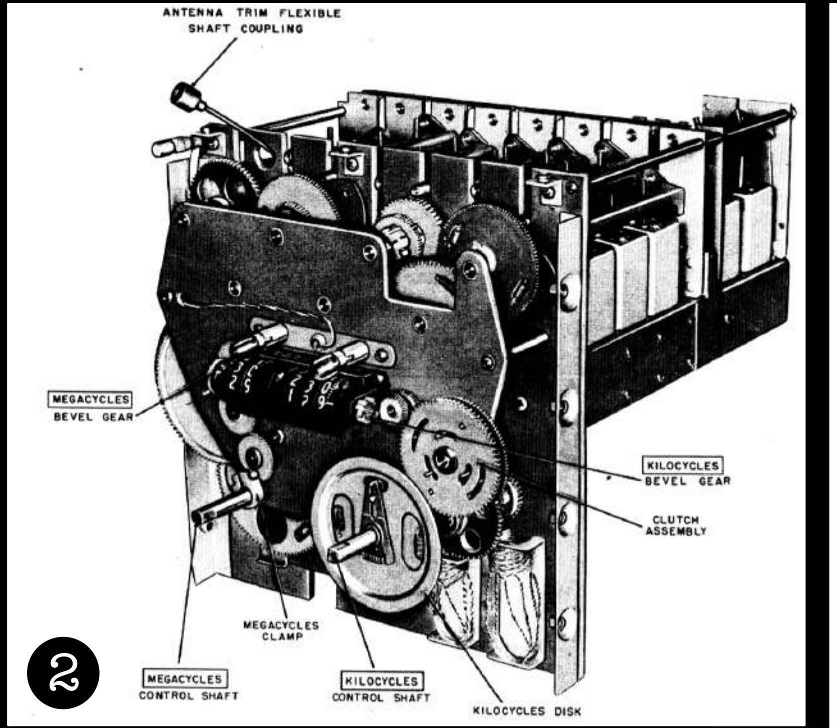
R-392

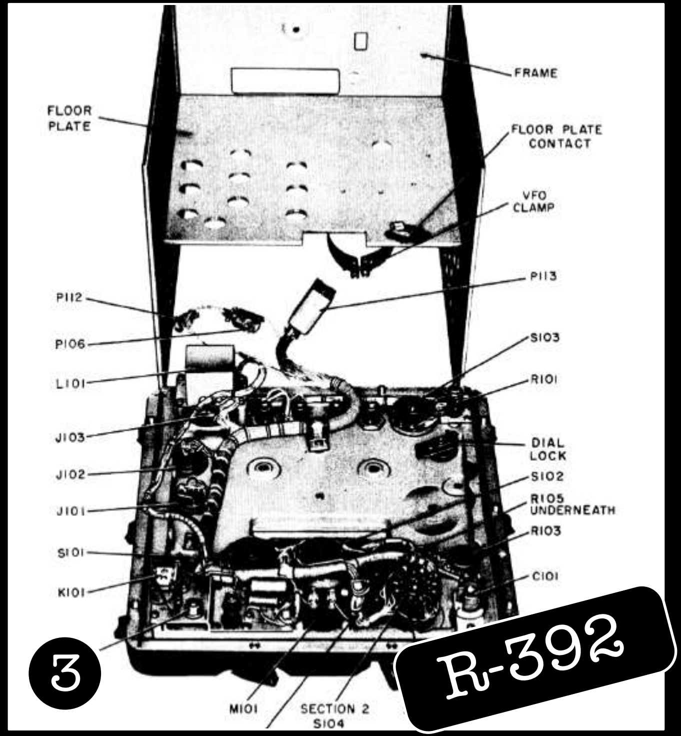

R-392
WARNING SEALED UNIT
C706
V605 6AJ5
V604 26A6
V606 6AJ5
J615
J614
J613
METER ZERO
MOD
V703 12AU7
1

392, more than a small 390

In R-392 you can find many of the solutions adopted for the R-390(A), ...just shrunk. Surely, one of the design constraints was temperature. Even with only 28V plate voltage, the unit is completely sealed and the heat remain confined to a reduced volume. For that reason, the MFP anti-fungus coating produces a typical smell. When you open one of them for the first time, you think "OMG, here something is burned". But that's normal: if you love this R-392 like me, you will consider it perfume...

❶ The receiver, seen from below. The tuning gear box is visible behind the front panel. Center left is the Crystal Calibrator module, then the PTO and center right is the AF audio module. At the rear top is the IF module. Like the R-390/URR, the R-392 modules interconnect using cables and plugs. All modules are secured using captive screws that have their heads painted green. The AF final tube (red arrow) is responsible of a big part of the heating. In the latter units, it was replaced by a semiconductor equivalent. ❷ the HF chassis is a miniature version of the R-390 one. ❸ almost like 390, the R392 is completely modular and can be split in major subassemblies with relative ease. The construction is made almost entirely in aluminum.


ANTENNA TRIM FLEXIBLE SHAFT COUPLING
MEGACYCLES BEVEL GEAR
KILOCYCLES BEVEL GEAR
CLUTCH ASSEMBLY
MEGACYCLES CLAMP
MEGACYCLES CONTROL SHAFT
KILOCYCLES CONTROL SHAFT
KILOCYCLES DISK
2


FRAME
FLOOR PLATE
FLOOR PLATE CONTACT
VFO CLAMP
P113
P112
P106
L101
S103
R101
J103
J102
J101
S101
K101
DIAL LOCK
S102
R105 UNDERNEATH
R103
C101
M101
SECTION 2 S104
3
R-392

T-195: all by itself

Today, after the introduction of computers and microprocessor, we are used to devices capable of managing themselves, adapting to different boundary conditions. But in the '50s, a human being was normally the brain of an equipment, so the T-195 transmitter represents a real quantum leap, being equipped with many parts capable of doing some operations by themselves.

The T-195 could:

- *store and recall up to 8 different operative frequencies, with a wonderful mix of gears, relays, motors and contacts. The recall operation is really impressive!*
- *tune the PA and antenna in a completely automatic way.*

In this manner, the operator had only to set the switch of the required channel and press the microphone button. The tuning starts and, when finished, after some seconds, a light tells the operator that the conversation can start. This model was surely well accepted by the Army, raising the soldiers from the duty of properly setting-up the communication equipment, probably being, during a battle, more involved in other activities...

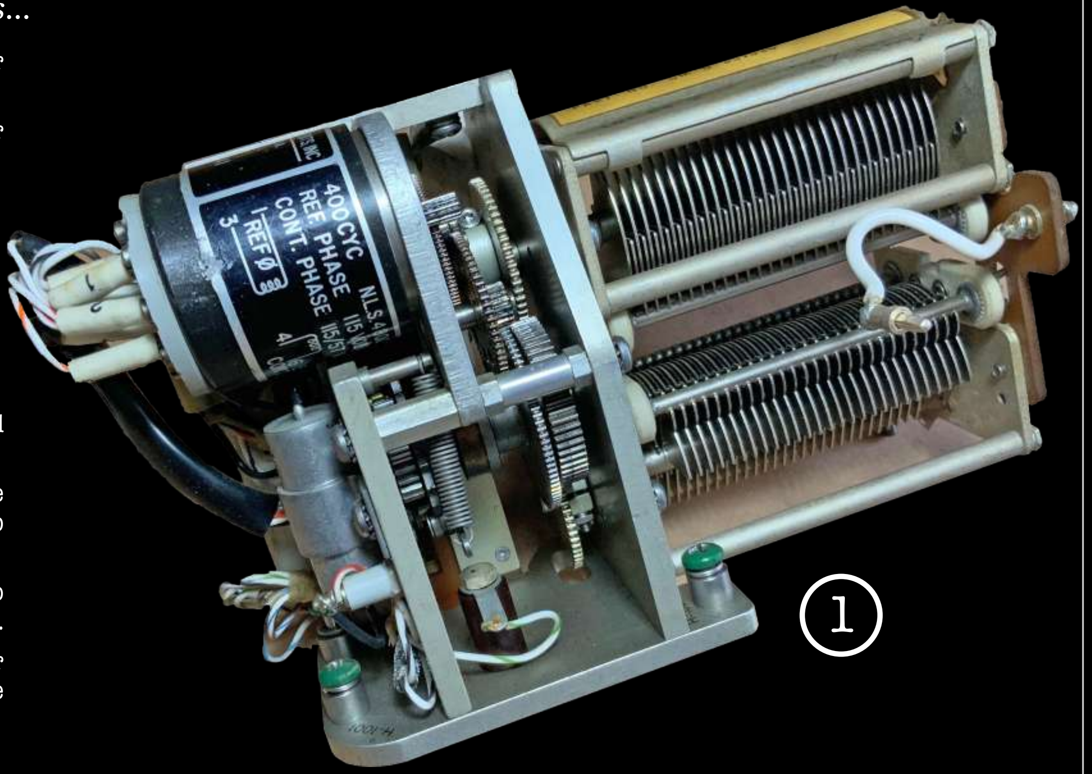
❶ The motorized antenna tuning capacitor subchassis.

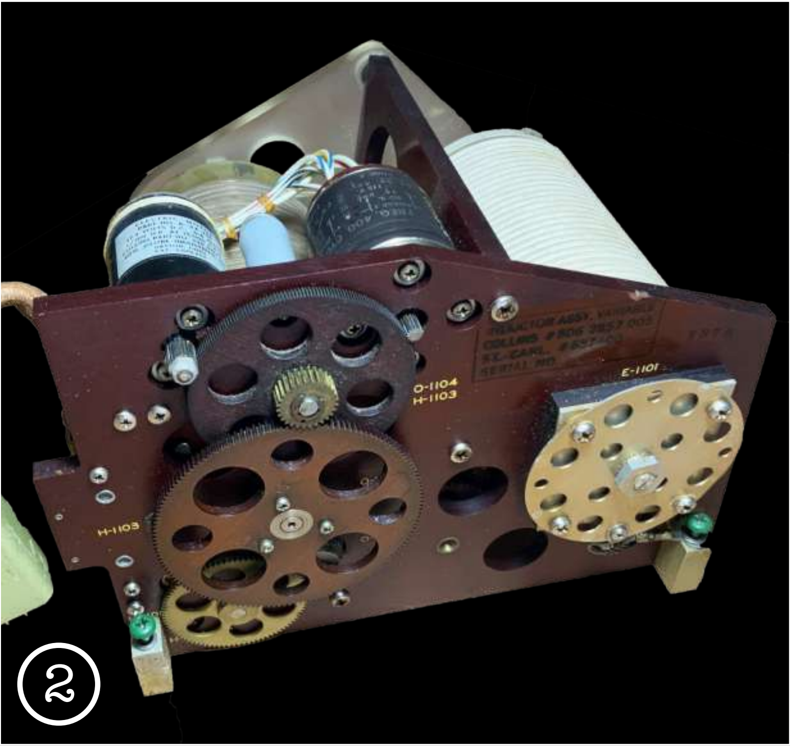
❷ The motorized antenna variable inductor subchassis is composed by two cylinders, one in ceramic and the other in metal. On the cylinders, a wound-up metal ribbon constitutes the variable inductor coil (see the details on next page). When the ribbon is wound on the metal cylinder, the inductance is at the minimum, when on the ceramic cylinder, it is at the maximum, wit all the possible intermediate values. Note that there are two motors: a DC motor for initial set-up and a servo motor for tune-up.

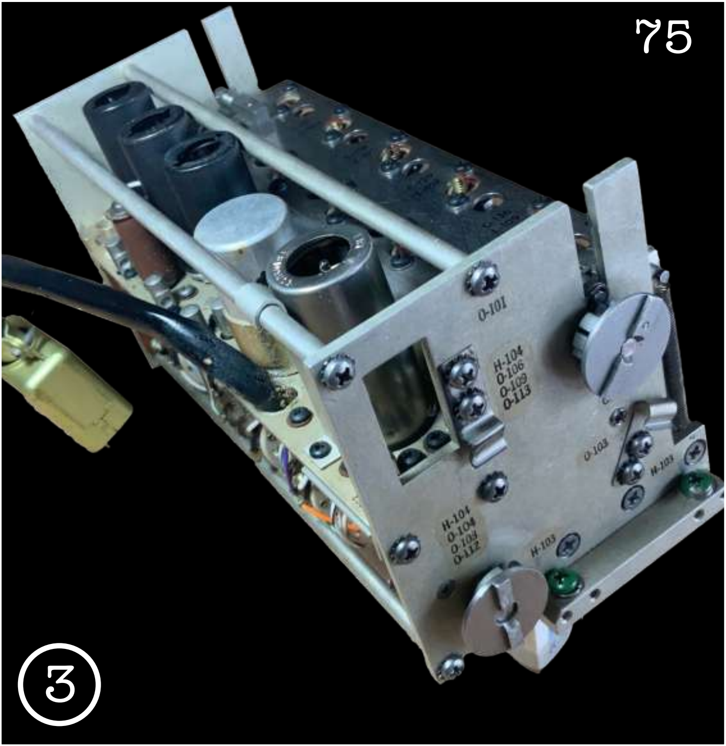
❸ The exciter subchassis. It use the same technology of R-390, with cam operated, up and down, moving slugs inside inductors.

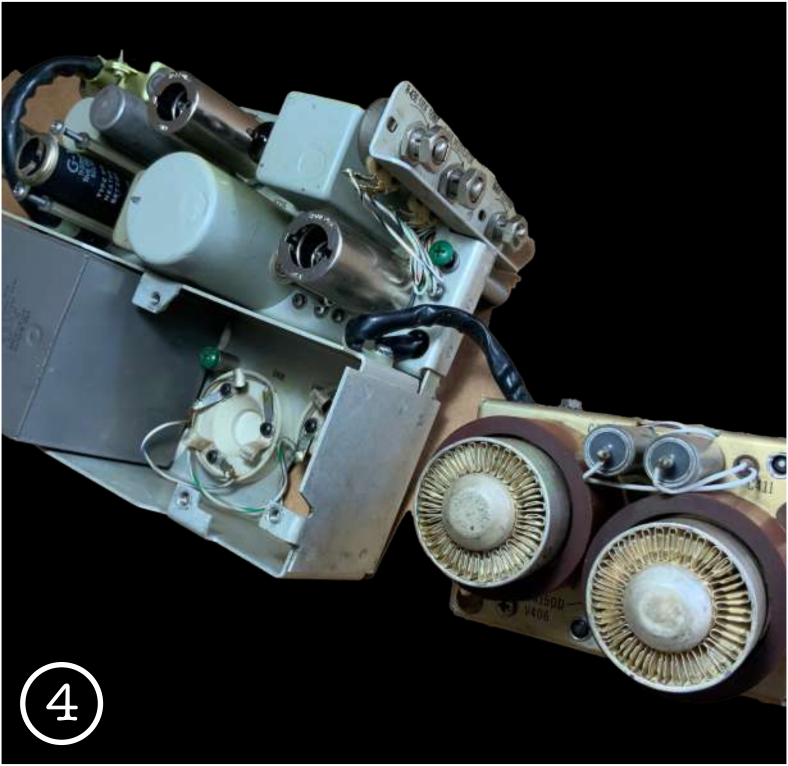
❹ The modulator subchassis, with the two 4X150 tubes, operate at 1,000V plate voltage.

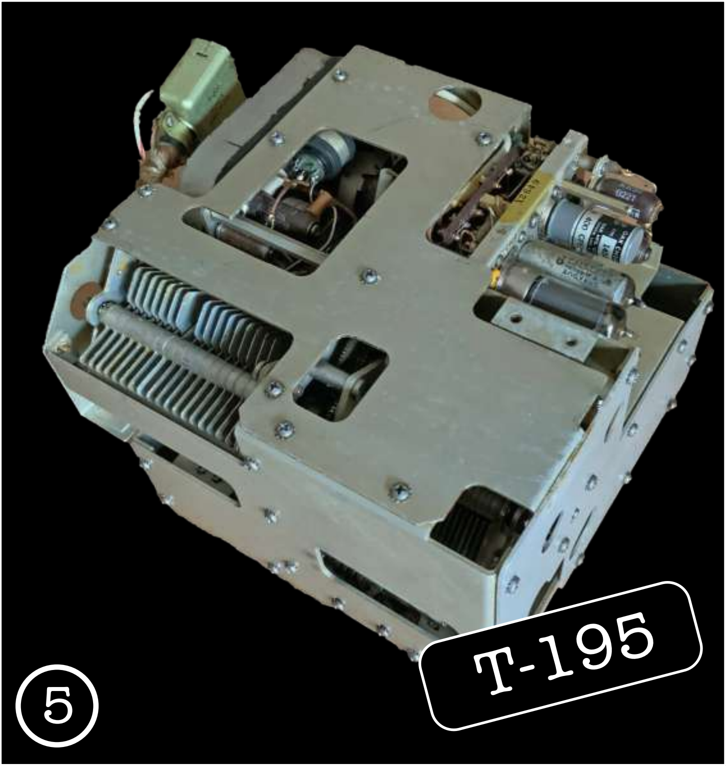
❺ The PA subchassis. It includes another servo-motorized capacitor. It uses just one 4X150 tube in the final stage.











T-195: positioning

But how could the T-195 do all these miracles? Its secret represented by the two-phase, induction , ***servo motors,*** *very similar to today's stepper motors, but used in a different way.*

Each motor has two windings. One is constantly fed with a fixed sinusoidal voltage (Vm). The other is controlled by a sinusoidal voltage out of phase by 90 ° (Va). When Va = Vm, the motor runs. By reducing Va, the motor runs slower and slower, until it stops, when Va = 0. By reversing the phase, the motor turns backwards.

A circuit (called ***discriminator****) measures the position error of the capacitor (or the inductor) and produces a DC voltage proportional to the error. A 400 Hz chopper slices and transforms this voltage into a rectangular signal, which is then transformed into sinusoidal by the* ***servo amplifier****.*

The sequence is: 1) the discriminator detects the error to be corrected; 2) the chopper converts that DC voltage into a rectangular wave at 400 Hz; 3) the servo amplifier transforms that square wave into a sinusoidal wave, of suitable amplitude to drive the second motor winding (Va).

And all that without any microprocessor or software...

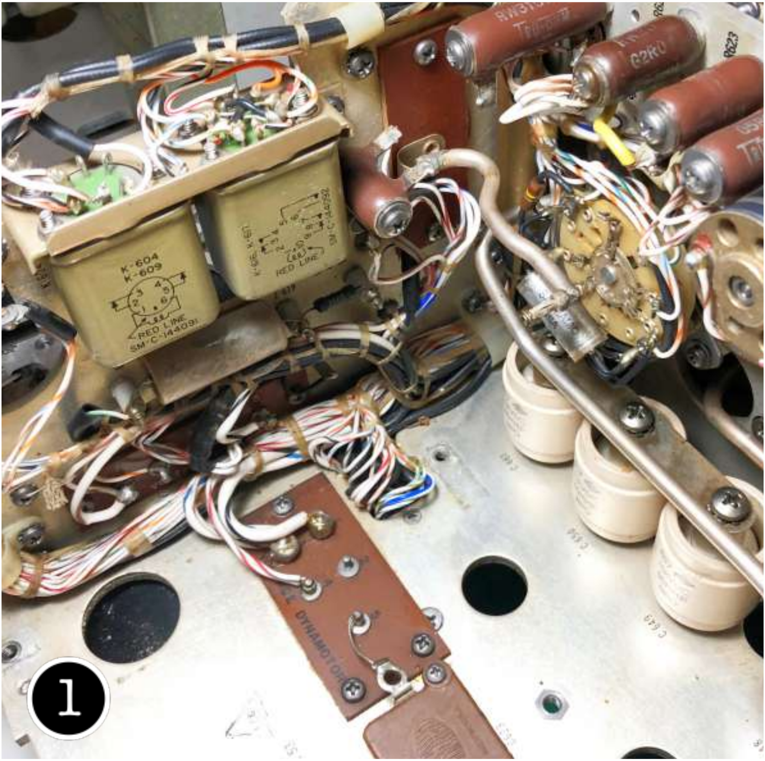
❶ Several relays are used to sequence the various operations. Understanding their logic it's not easy and require to study carefully the TM-11806 instructions book, not always so clear or correct.

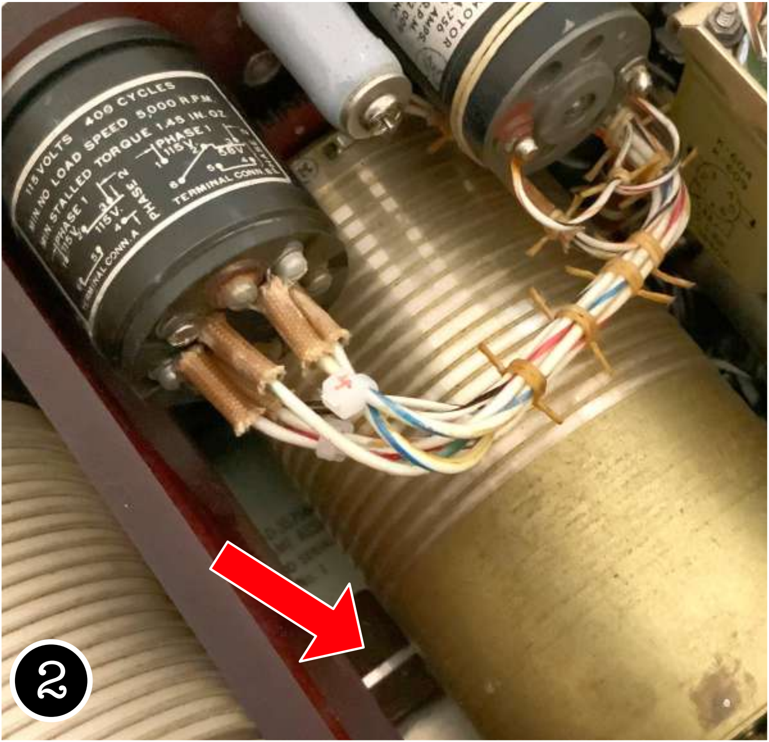
❷ A detail of the variable inductor antenna chassis described in the previous page. The arrow shows the metal ribbon. Again, note the presence of two motors: the DC one is only for the initial positioning, whilst the second is the servo for the tuning.

❸ After the restoration, it was a big satisfaction to see the T-195 automatically reach almost all its original power: its second life has been started!

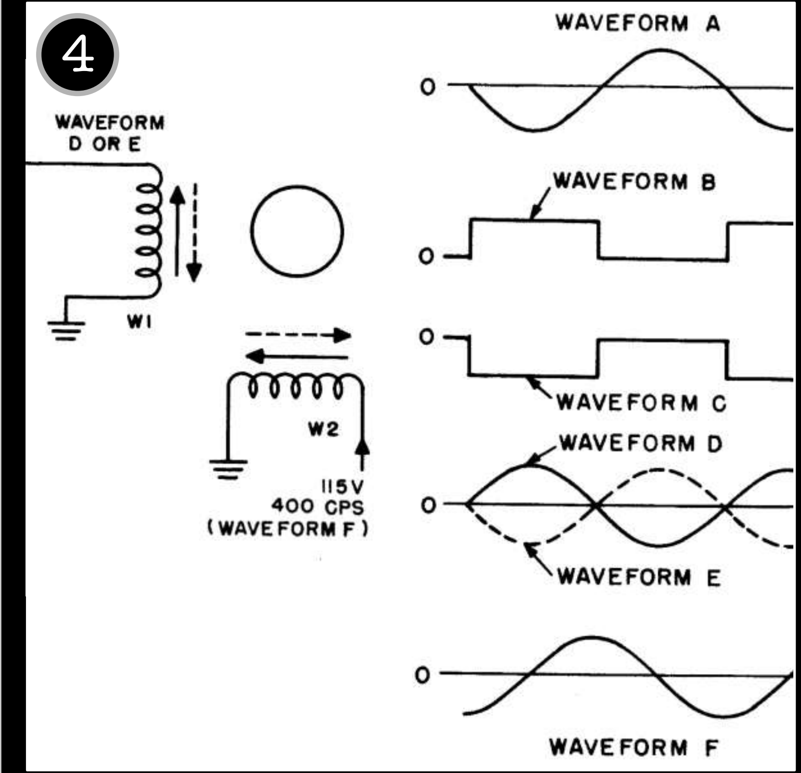
❹ The waveforms described in the text.

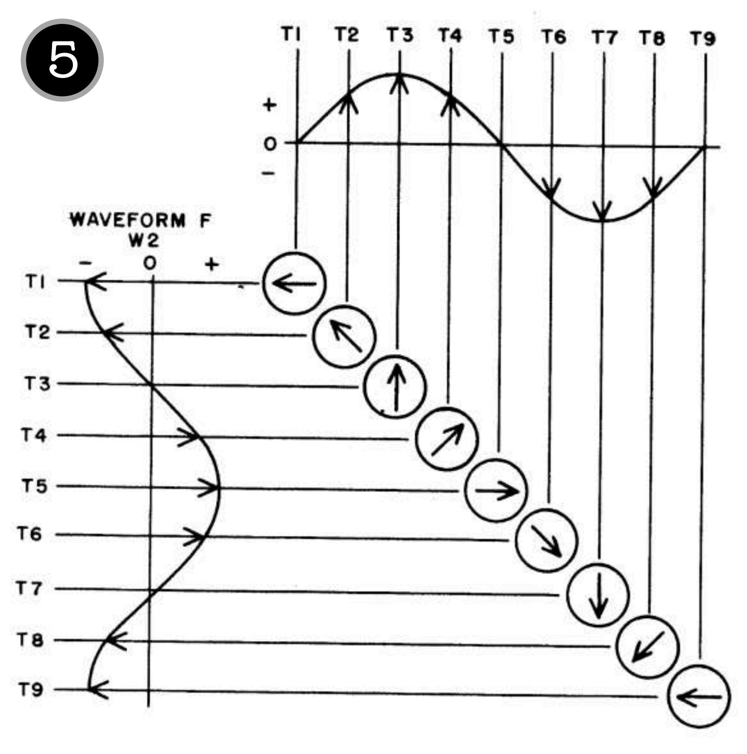
❺ How can the motor is able to rotate.

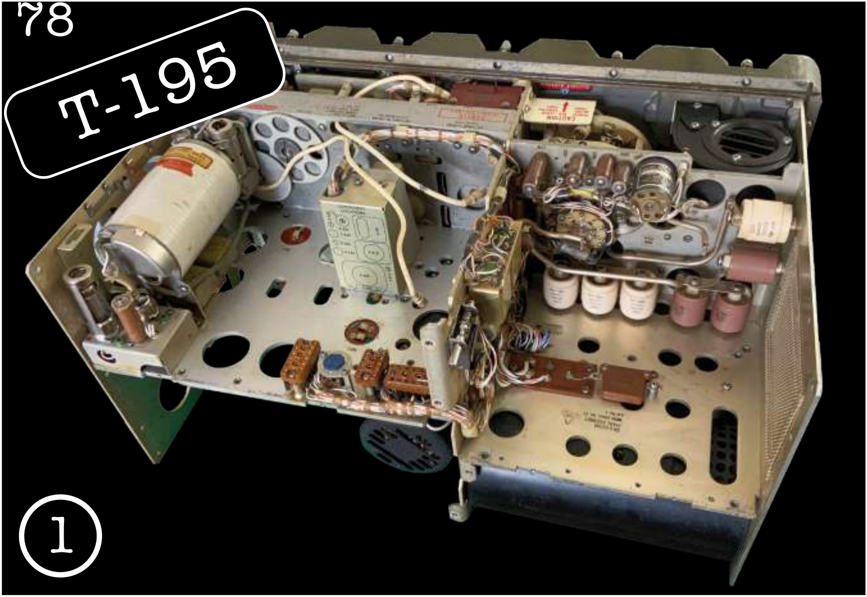


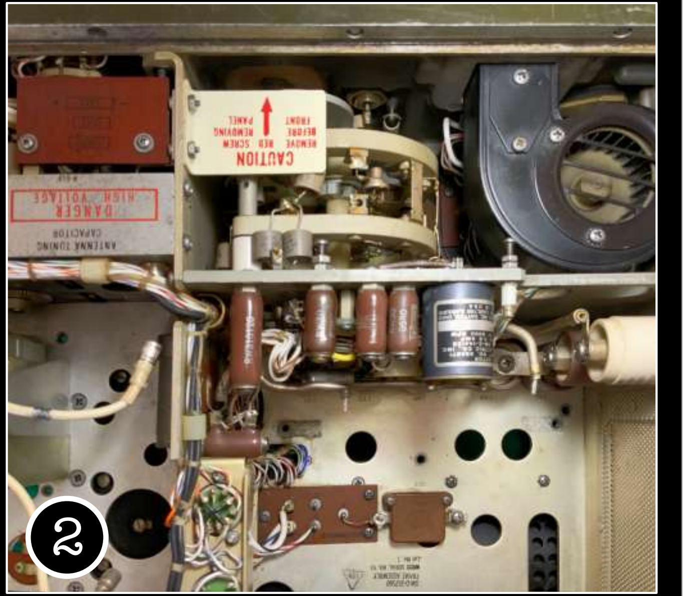


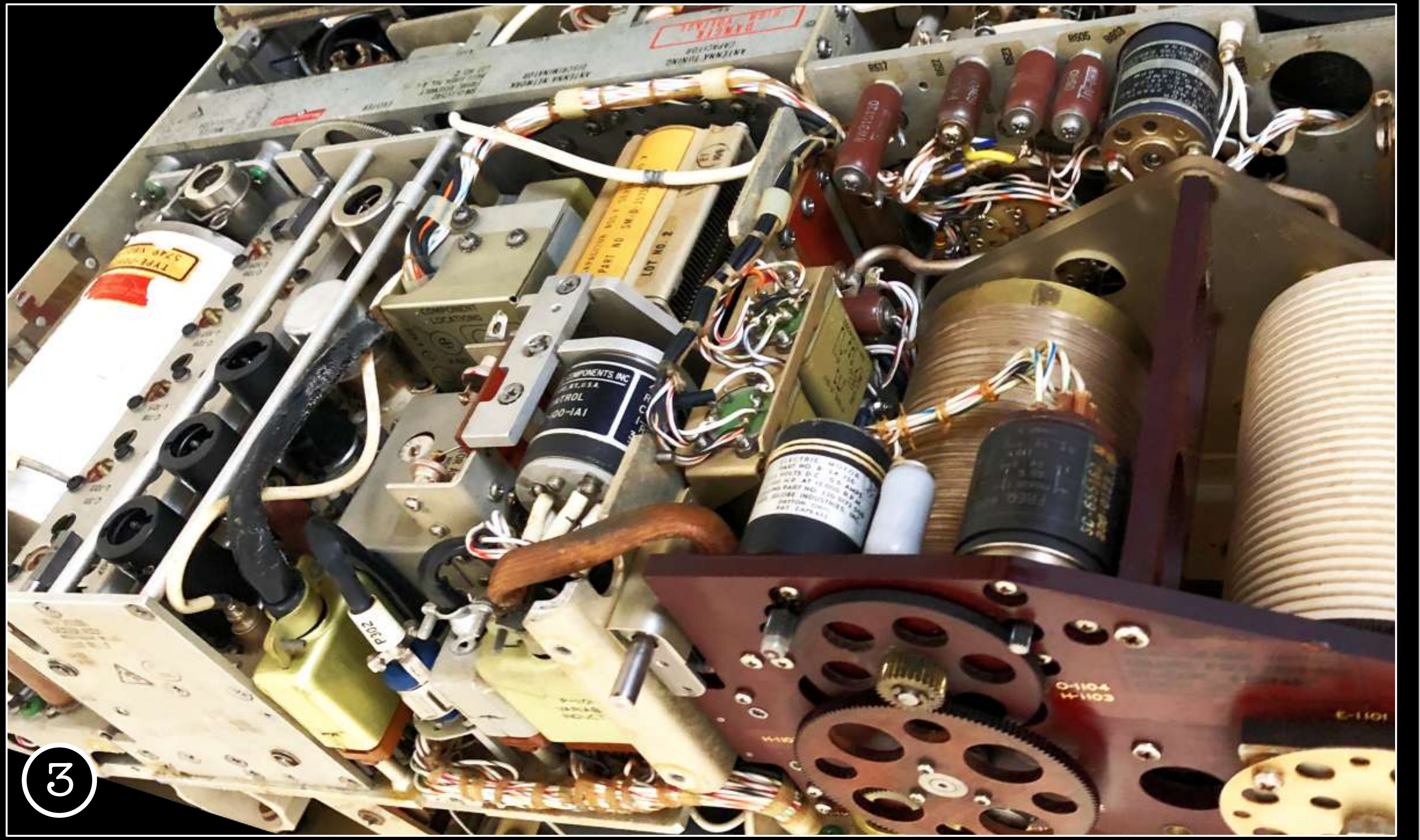
T-195
WATTS
BAYLY
3











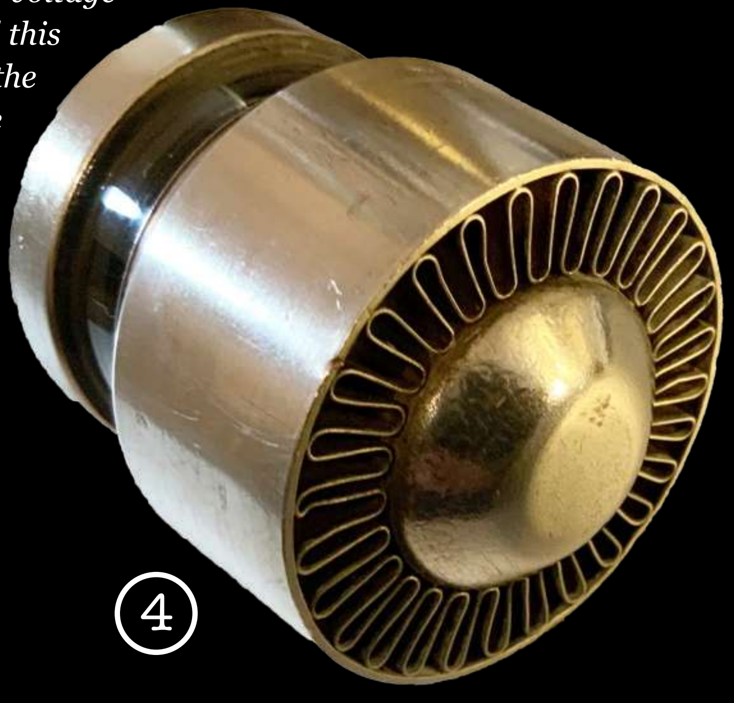
No room is wasted

I cannot imagine how long it took to design a monument like that, with 22 tubes, lot of motors, and weighting more than 50 kg (122 lbs). A huge amount of this time was probably due to packing together all that stuff. Apparently, no room is wasted and seeing the T-195 internals is by itself a spectacle.

The construction is entirely modular, and it is easy enough to split the T-195 in the many subchassis which compose it, making its maintenance definitively not easy, but at least possible. All the subchassis are connected by mean of multi-pin connectors or by incredibly smart direct contacts. Even for the 1,000V tension, proper plugs are provided.

That packaging made probably a problem the heat dissipation and required to use a strong forced air flow, produced by more than one hurricane-like fans, that make the T-195 definitely noisy. Often, when I switch it on, a lot of paper sheets fly all around the room...

But... how to feed the monster? The original T-195 required more that 45A @ 28V, with a huge peak to start-up the hi-voltage dynamotor, and it's really difficult to supply him all this power. In the latest models, T-195B like mine, both the dynamotors were replaced by equivalent solid state units, which sensibly reduced start-up peak. I used a low-cost, switching power supply, adding lot of capacitors (60,000uF) , to avoid problems with the electronic dynamotors, less robust than originals.



❶ The mainframe top, with some modules removed. Note, on the left, the variable inductor used for the VFO, smaller but similar to the R-390 one.

❷ This ceramic unit is the antenna output capacitor switch, controlled by a DC motor according to the frequency band. On the right, the centrifugal fan.

❸ No room is wasted indeed...

❹ One of the three beautiful 4X150D tubes used in T-195, one in the PA, the other two in the modulator. They allow to put into the antenna about 100W RF.

Allocchio Bacchini AC-18 receiver

The Allocchio Bacchini & C. was founded in Milan in 1920 by two partners, Antonio Allocchio and Cesare Bacchini. The company began its activities in a laboratory with few workers and was active in the construction of electrical measuring instruments and equipment for telegraphy, radiotelephony and radiotelegraphy.

In 1940 the company had 2,000 workers in four factories and about fifty employees, 20 of whom were design engineers. With the outbreak of the Second World War, the company started producing military equipment, well known, after the end of the war, on the Italian surplus market.

Destroyed by the bombings of 1943 on Milan, continued however its business with ups and downs until the end of the sixties, when it closed definitely.

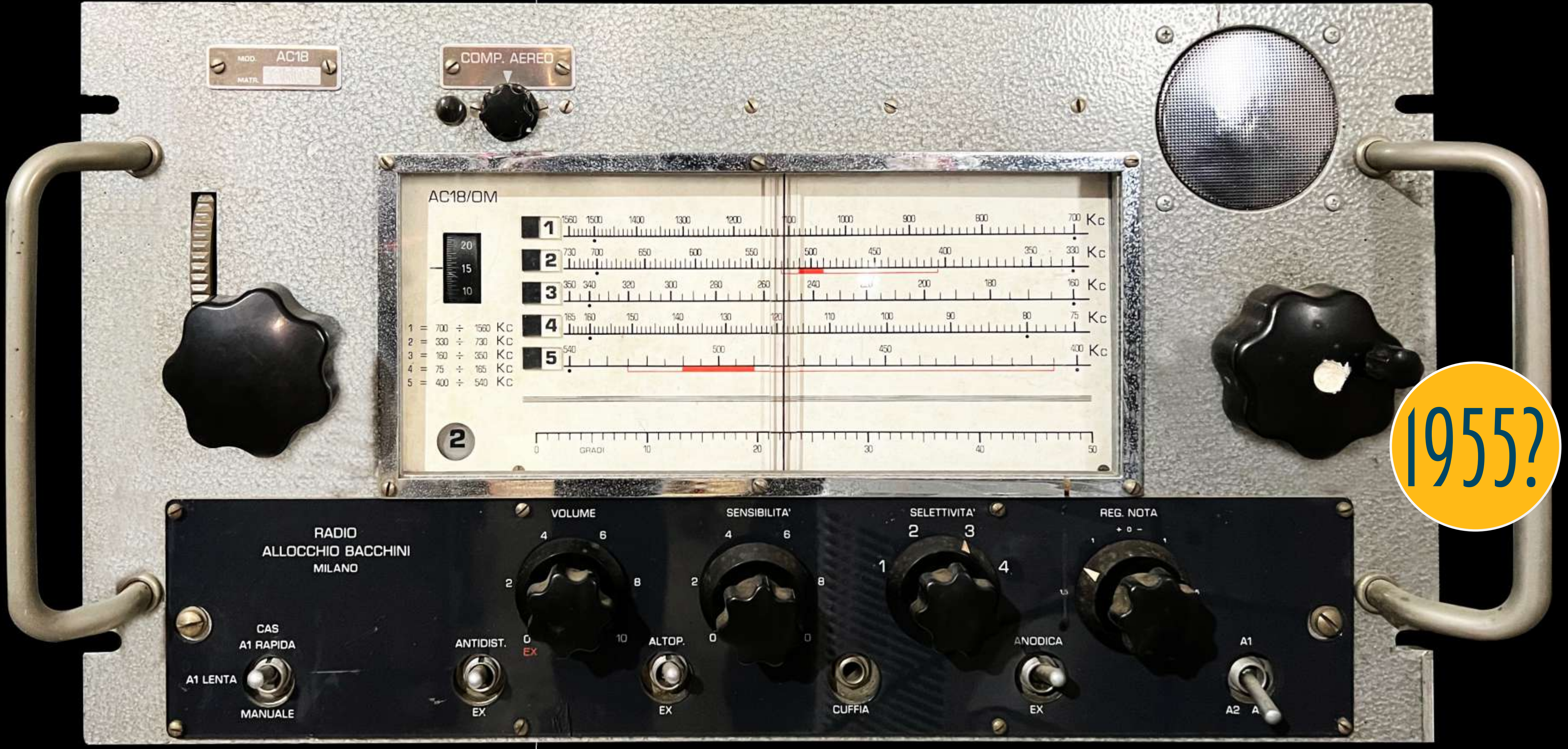
Among their activities, the invention of the radio beacon, in someway similar to radar.

The AC 18, depicted here, was a receiver from 75 kHz to 1,560 kHz. It is rare and seems almost impossible to find information about it on the Internet.

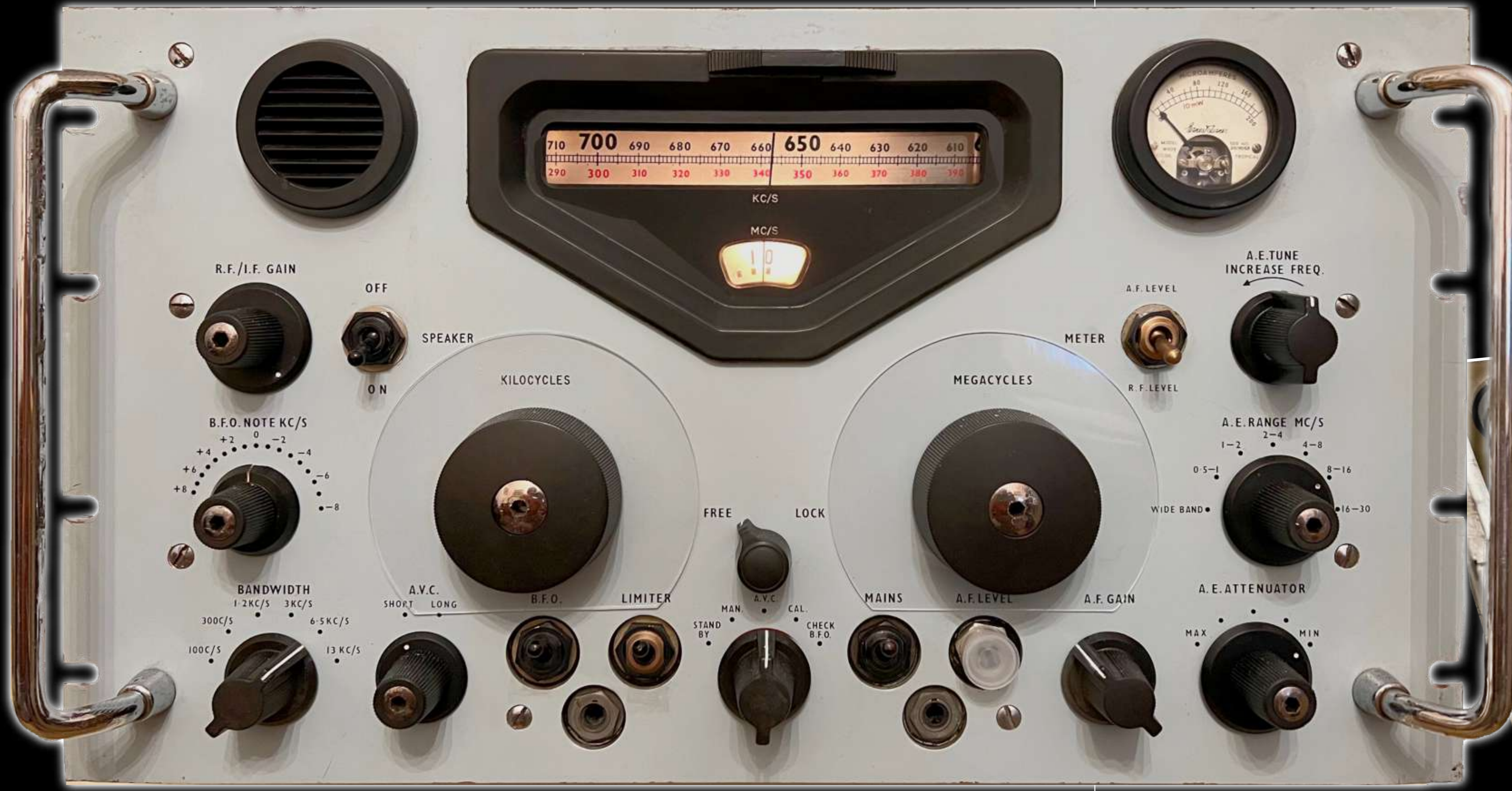
Freely taken from Wikipedia

Italian equipment

Once again, thanks to Francesco Sartorello, owner of this Allocchio Bacchini AC18.


MOD. AC18
MATR.
COMP. AEREO
AC18/OM
1 = 700 ÷ 1560 Kc
2 = 330 ÷ 730 Kc
3 = 160 ÷ 350 Kc
4 = 75 ÷ 165 Kc
5 = 400 ÷ 540 Kc
GRADI
RADIO
ALLOCCHIO BACCHINI
MILANO
VOLUME
SENSIBILITA'
SELETTIVITA'
REG. NOTA
CAS
A1 RAPIDA
A1 LENTA
MANUALE
ANTIDIST.
EX
ALTOP.
EX
CUFFIA
ANODICA
EX
A1
A2

1955?

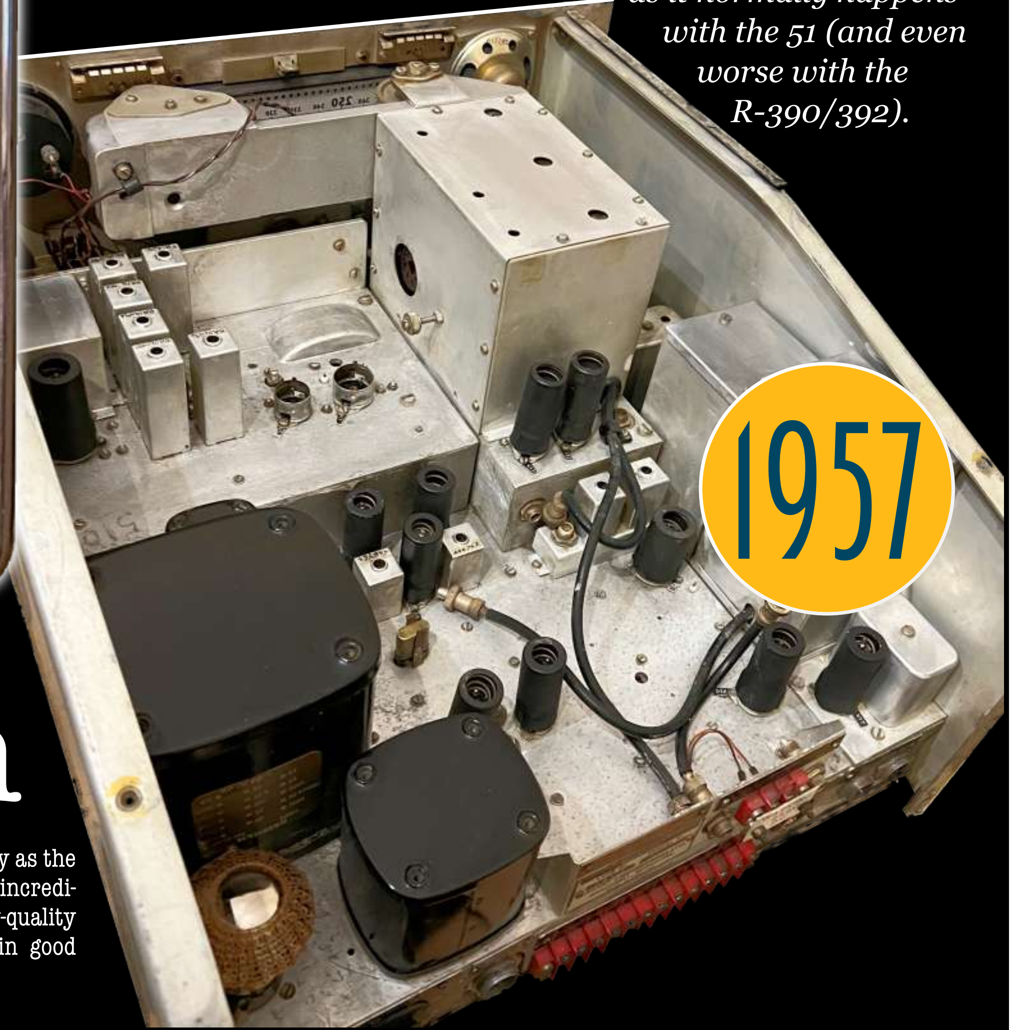

KC/S
MC/S
R.F./I.F. GAIN
OFF
SPEAKER
ON
KILOCYCLES
MEGACYCLES
METER
A.F. LEVEL
R.F. LEVEL
A.E. TUNE
INCREASE FREQ.
B.F.O. NOTE KC/S
A.E. RANGE MC/S
WIDE BAND
FREE
LOCK
BANDWIDTH
A.V.C.
SHORT
LONG
B.F.O.
LIMITER
MAN.
A.V.C.
CAL.
STAND BY
CHECK B.F.O.
MAINS
A.F. LEVEL
A.F. GAIN
A.E. ATTENUATOR
MAX
MIN

Racal RA17: David vs. Goliath

In 1953 the British Royal Navy became interested in having the small Racal (then) building a couple hundred Collins 51J successful receivers. But Collins, after visiting the Racal facilities, didn't want to license that small company, who, furthermore, wanted to use commercial parts built in UK. So, Racal decided to design its own receiver for the British Navy.

Racal commissioned the project to Trevor Wadley, who proposed using the "Wadley Loop", a circuit that he had developed in the 1940s, as the "heart" of the new Racal RA.17 receiver, which could perform like a Collins 51J, with superb frequency stability and 1 kHz dial readout accuracy, but with an entirely original design. In simple words, the trick was adding and then subtracting the frequency of the master oscillator, cancelling therefore its drift. That choice allowed Racal becoming one of the most important electronic companies in the world.

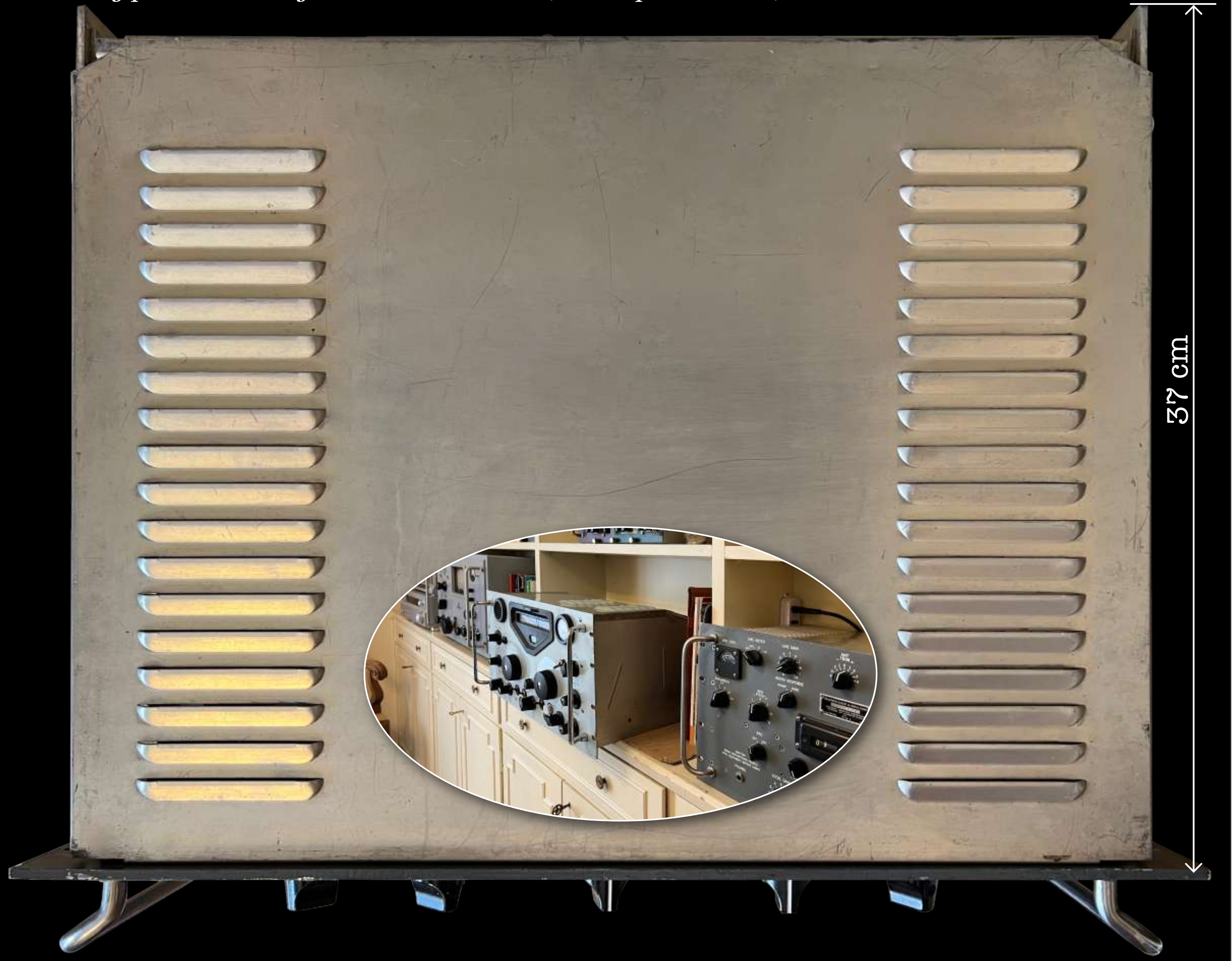
The Racal RA.17 had also another feature that I like: passing from 30 MHz to 500 kHz, does not require to ruin your wrists, as it normally happens with the 51 (and even worse with the R-390/392).

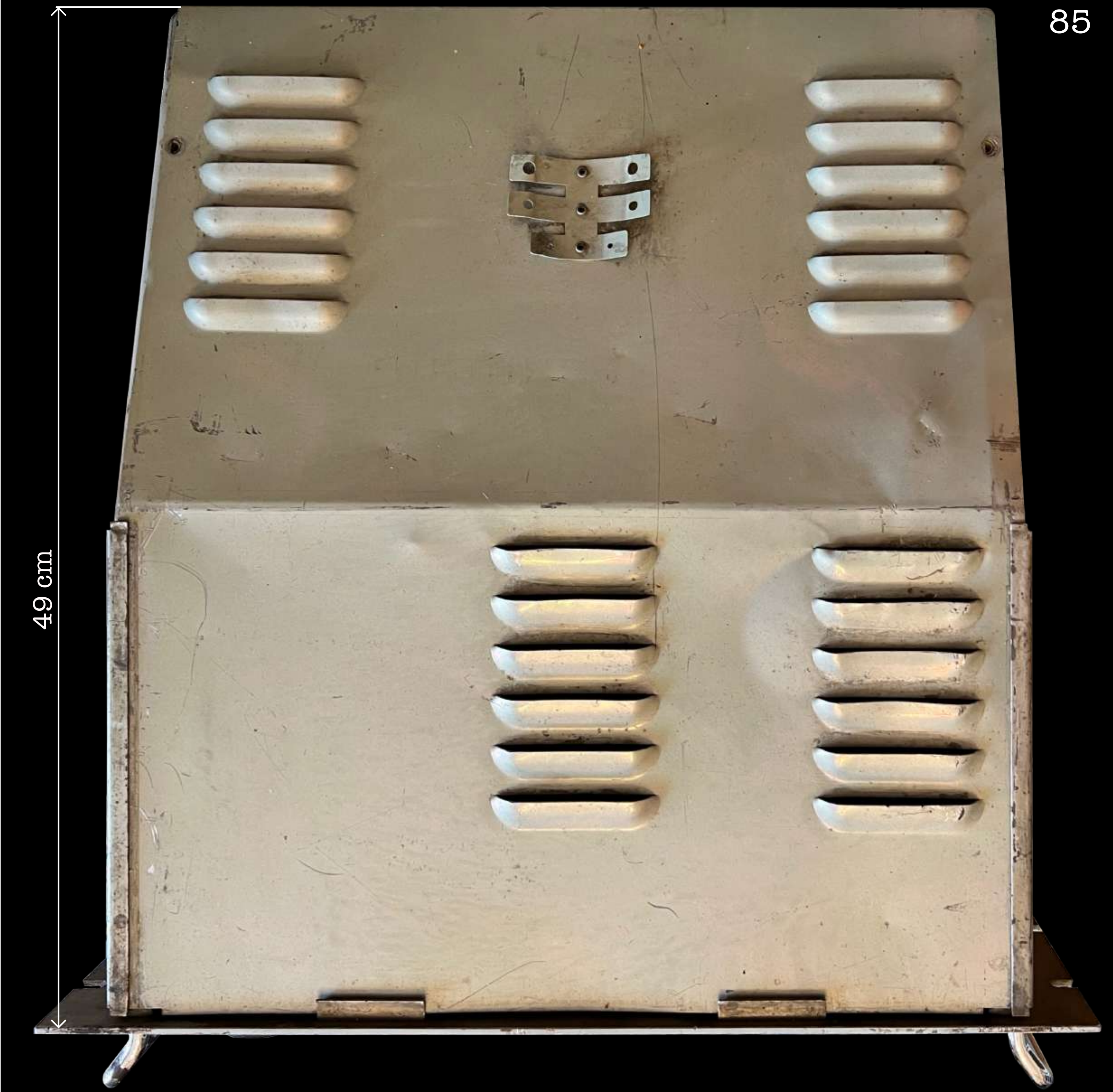


The construction of the Racal RA.17 is not so sexy as the Collins' one. Space is wasted and the receiver is incredibly longer than the 51J. In addition, it used low-quality commercial parts, that today are not always in good state. But it's however a wonderful receiver...

Not miniaturised

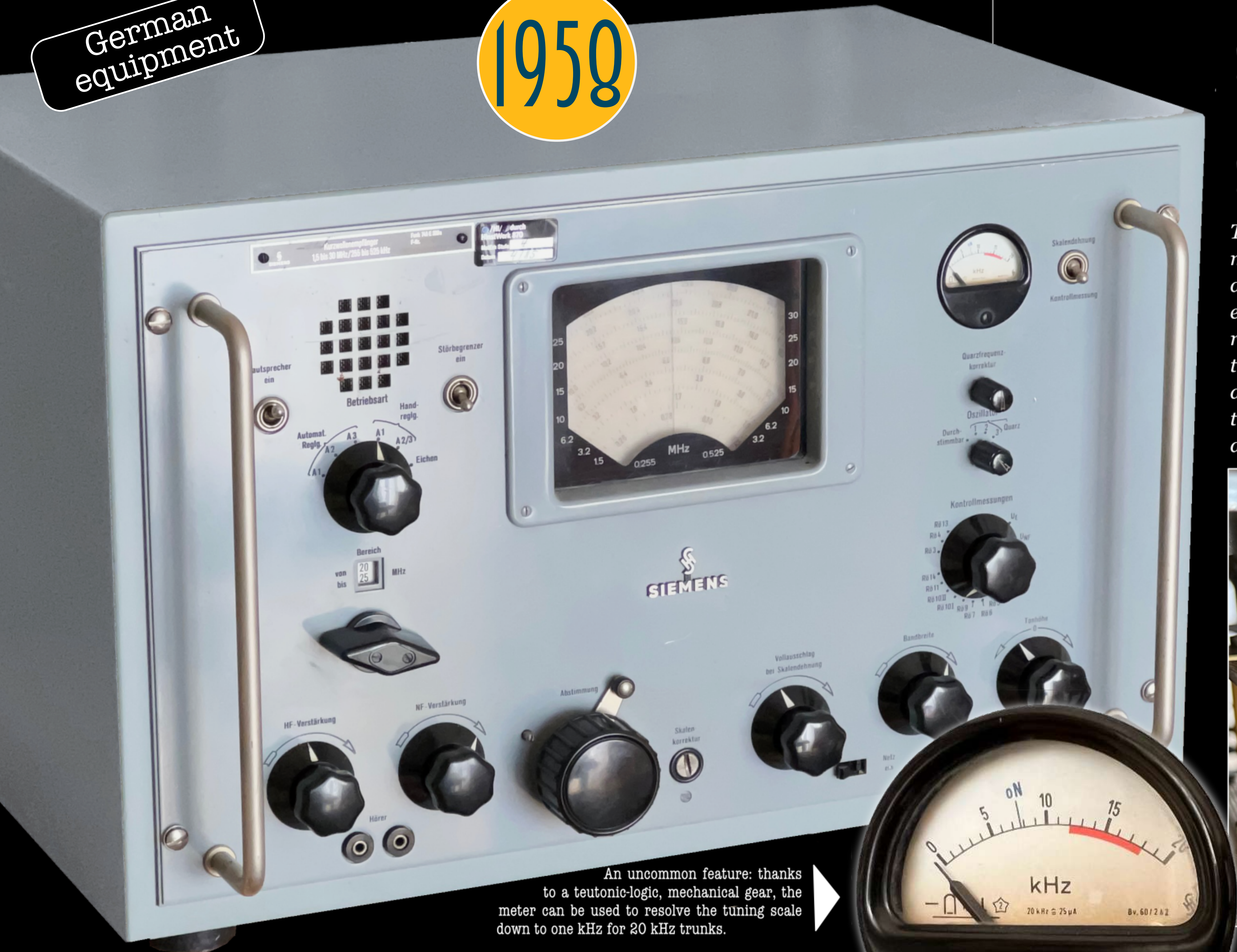
The strongest 390's commercial competitor was not engineered so well as the Collins pupil, and the room was somehow wasted with not so many regards. Considering its success, maybe that, in the fifties, the overall dimension of an HF receiver were not so important, but today the RA.17 depth is creating problems in my small home shack... (see the photo below)





German equipment

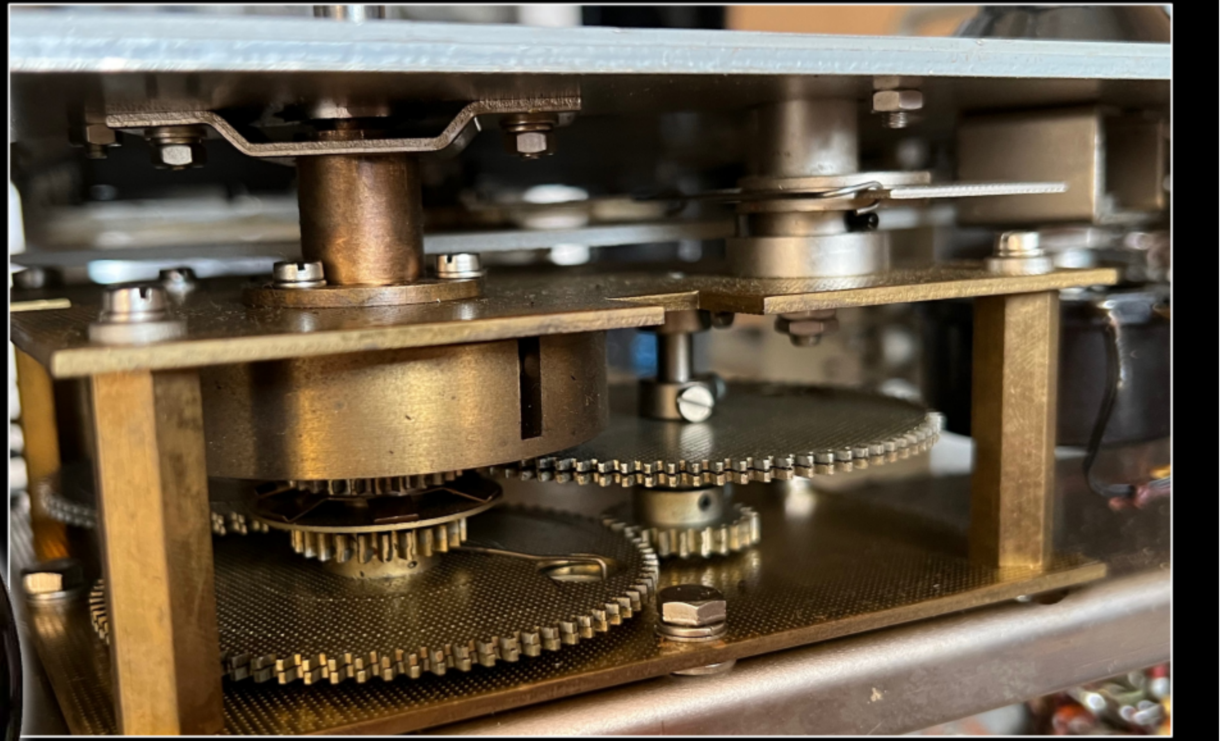
1958


Betriebsart
Störbegrenzer ein
Automat. Regl.
Hand-regl.
Eichen
MHz
Bereich
SIEMENS
HF-Verstärkung
NF-Verstärkung
Abstimmung
Hörer
Bandbreite
Kontrollmessungen
Quarzfrequenzkorrektur
Oszillator
Quarz
Skalendehnung
Kontrollmessung
kHz
0
5
ON
10
15
20

An uncommon feature: thanks to a teutonic-logic, mechanical gear, the meter can be used to resolve the tuning scale down to one kHz for 20 kHz trunks.

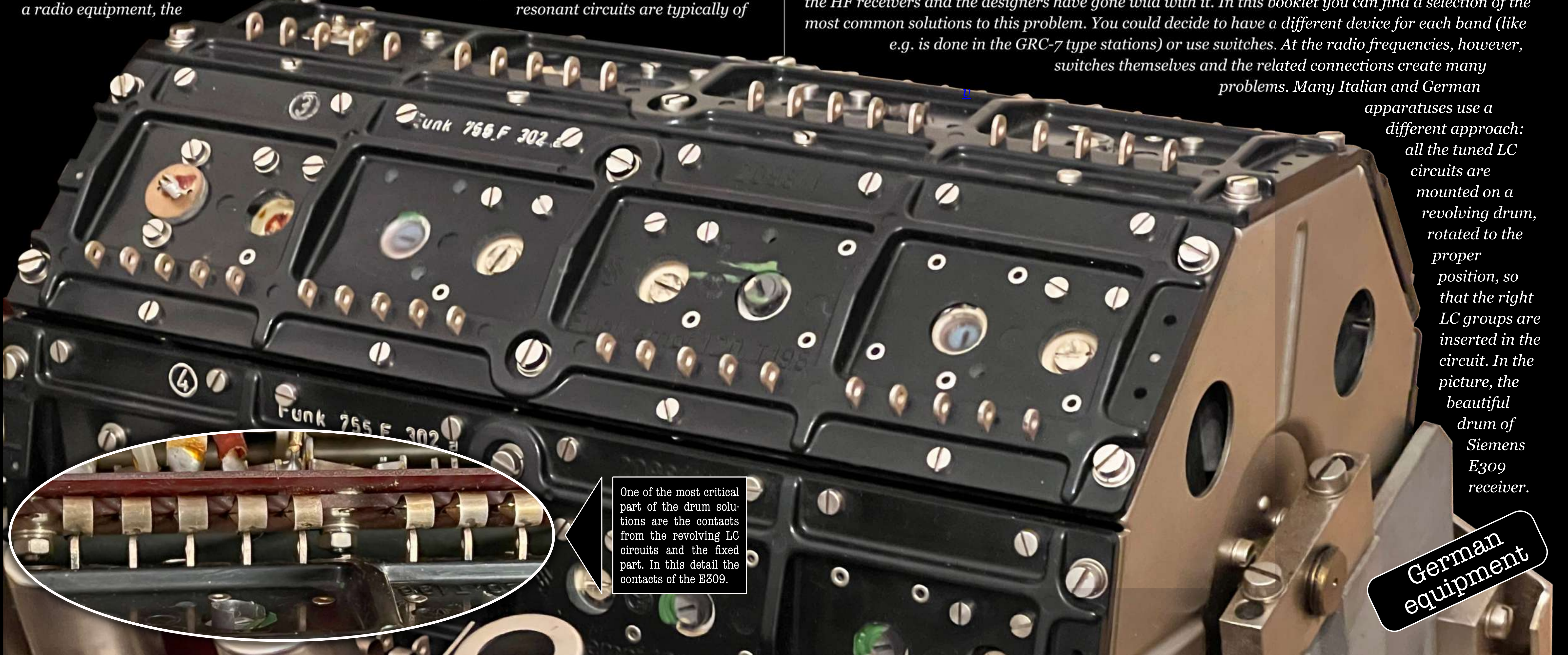
Sprechen Sie Deutsch?

The 1958 E309 is one of the last Siemens, professional tube receivers before moving toward the solid state technology. Personally, I find this receiver, simply delightful, perhaps the most pleasant in my experience. Its inertial tune knob is extra-smooth and precise, the scale is easy to read and the stability is almost rock-solid. To be noted, as well, the continuously variable bandwidth, the meter, that can help to diagnose the circuit, and the superb band change drum. But, above all, the marvellous German construction, more appreciable in my unit, that was still absolutely new and in the unopened original box (a giant THANKS again, my friend Francesco!).



Distant drums

***Resonance**: that's the base for all radio equipment. When something, not only electronic, resonates at the same frequency of some stimulus, the effect of this is incredibly **amplified**, in theory up to infinite. In a radio equipment, the resonant circuits are typically of the inductance/capacitance (LC) type. They are required in the input stage, the one connected to the antenna, to offer the best sensitivity to distant electromagnetic signals, but not only. More amplifying stages are required and they need other tuned circuits as well. Unfortunately, it is not easy to design a circuit good for all the frequencies, so the spectrum to be covered is split in **bands**. But, how to switch among the different bands? This is a common problem in most equipment, like, for example the HF receivers and the designers have gone wild with it. In this booklet you can find a selection of the most common solutions to this problem. You could decide to have a different device for each band (like e.g. is done in the GRC-7 type stations) or use switches. At the radio frequencies, however, switches themselves and the related connections create many problems. Many Italian and German apparatuses use a different approach: all the tuned LC circuits are mounted on a revolving drum, rotated to the proper position, so that the right LC groups are inserted in the circuit. In the picture, the beautiful drum of Siemens E309 receiver.*

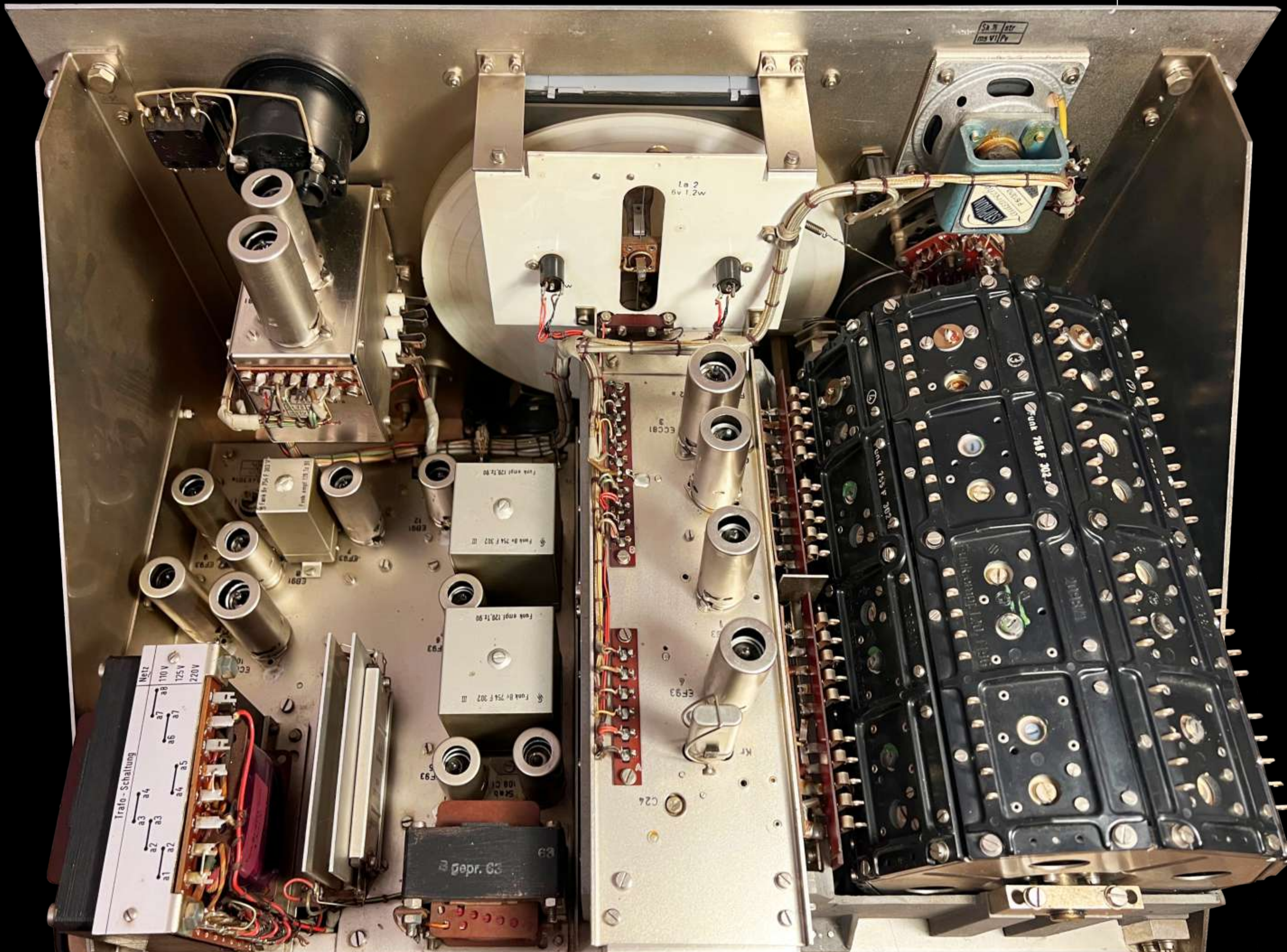


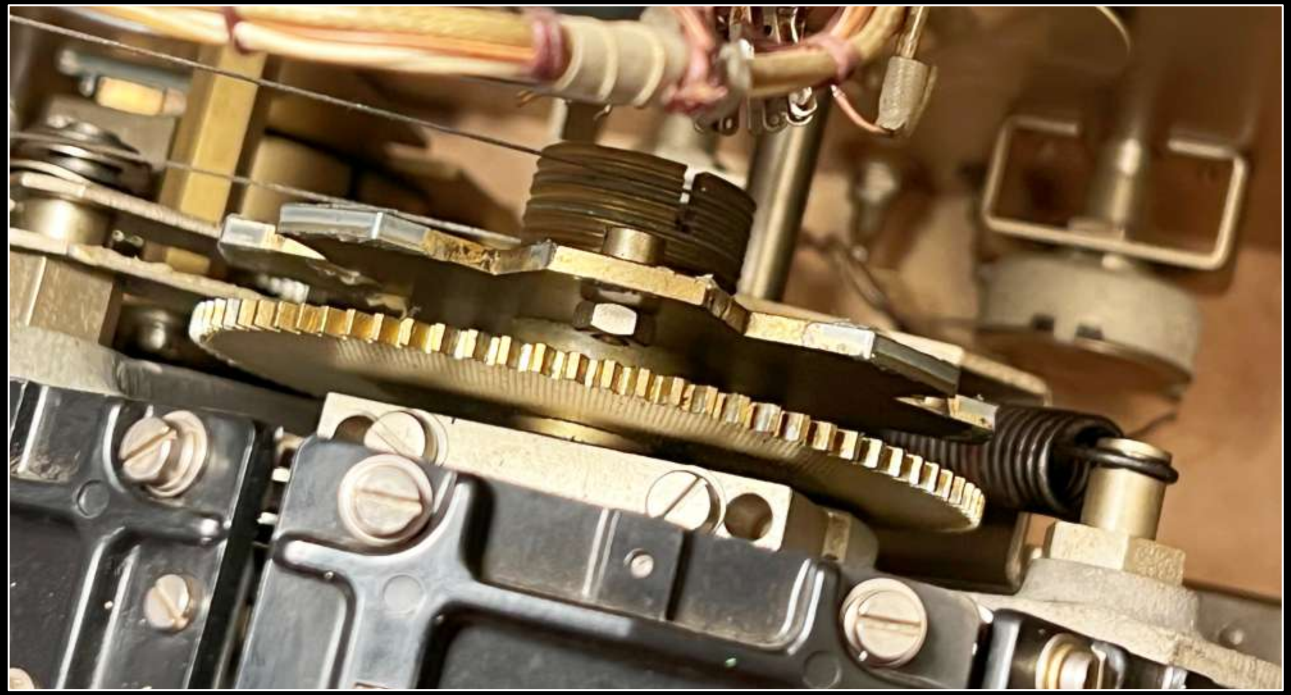
One of the most critical part of the drum solutions are the contacts from the revolving LC circuits and the fixed part. In this detail the contacts of the E309.

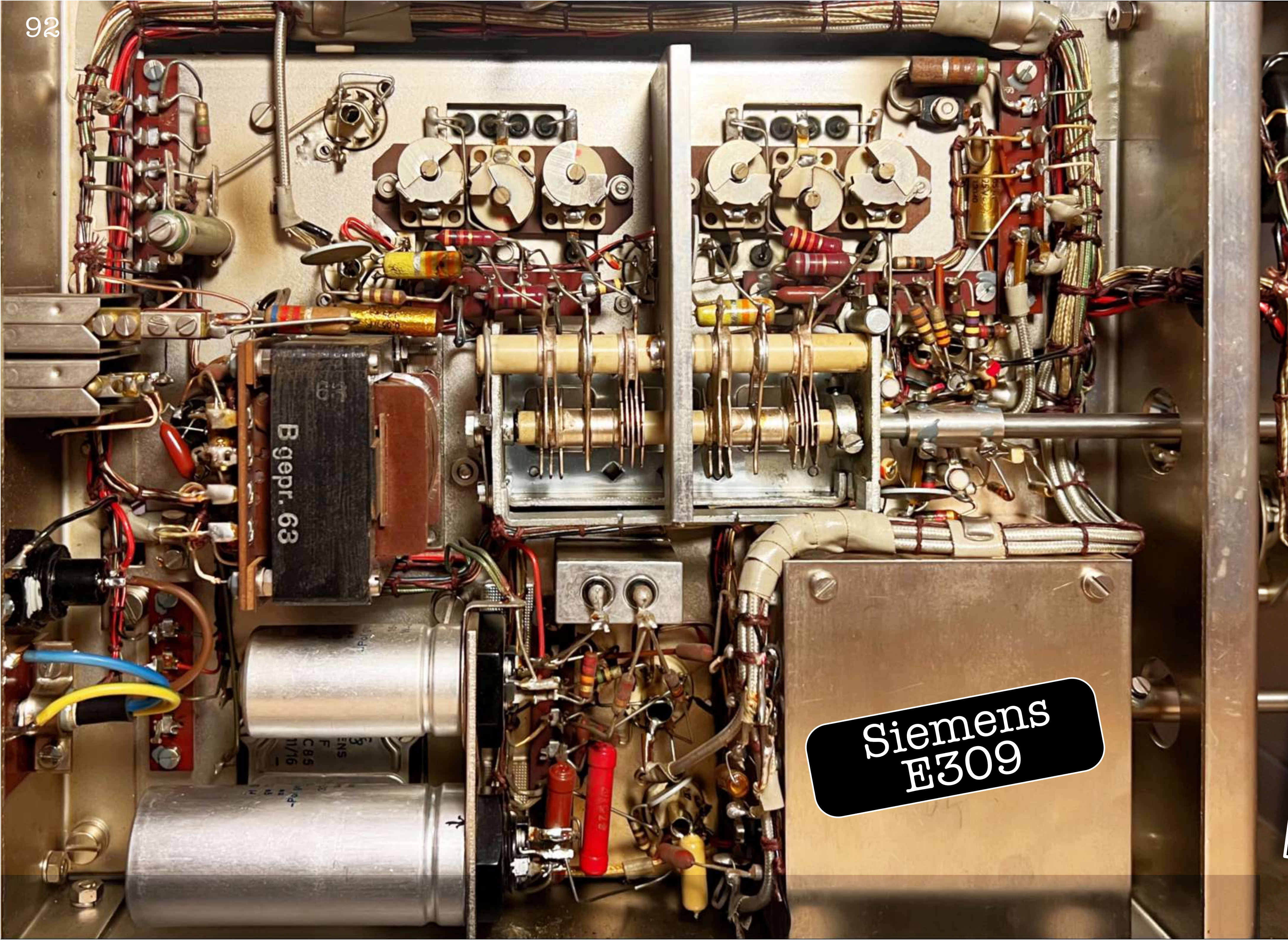
German equipment

German precision

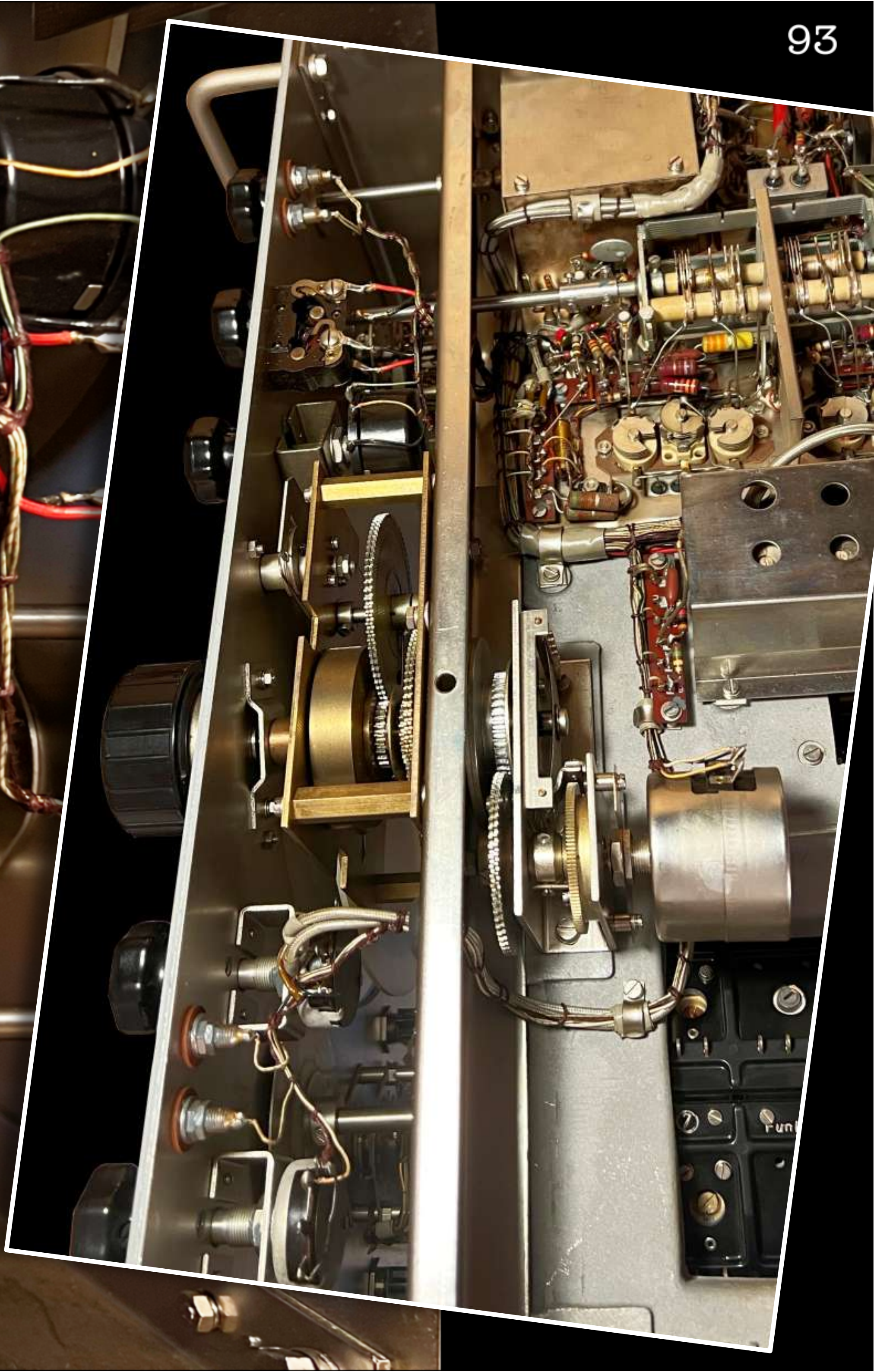
I thought that my E309, perhaps the best conserved piece of my collection, deserved the privilege of some extra photos here. Note the details: everything seem to be designed not only to be functional, but also nice to see. Every component, every wire seems to be placed in the rightest and thoroughly meditated position. Such a precision is less common in allied equipment, often more oriented to the results.


Trafo-Schaltung
Netz
110 V
125V
220V
gepr. C3
EF93
ECC81





Siemens
E309



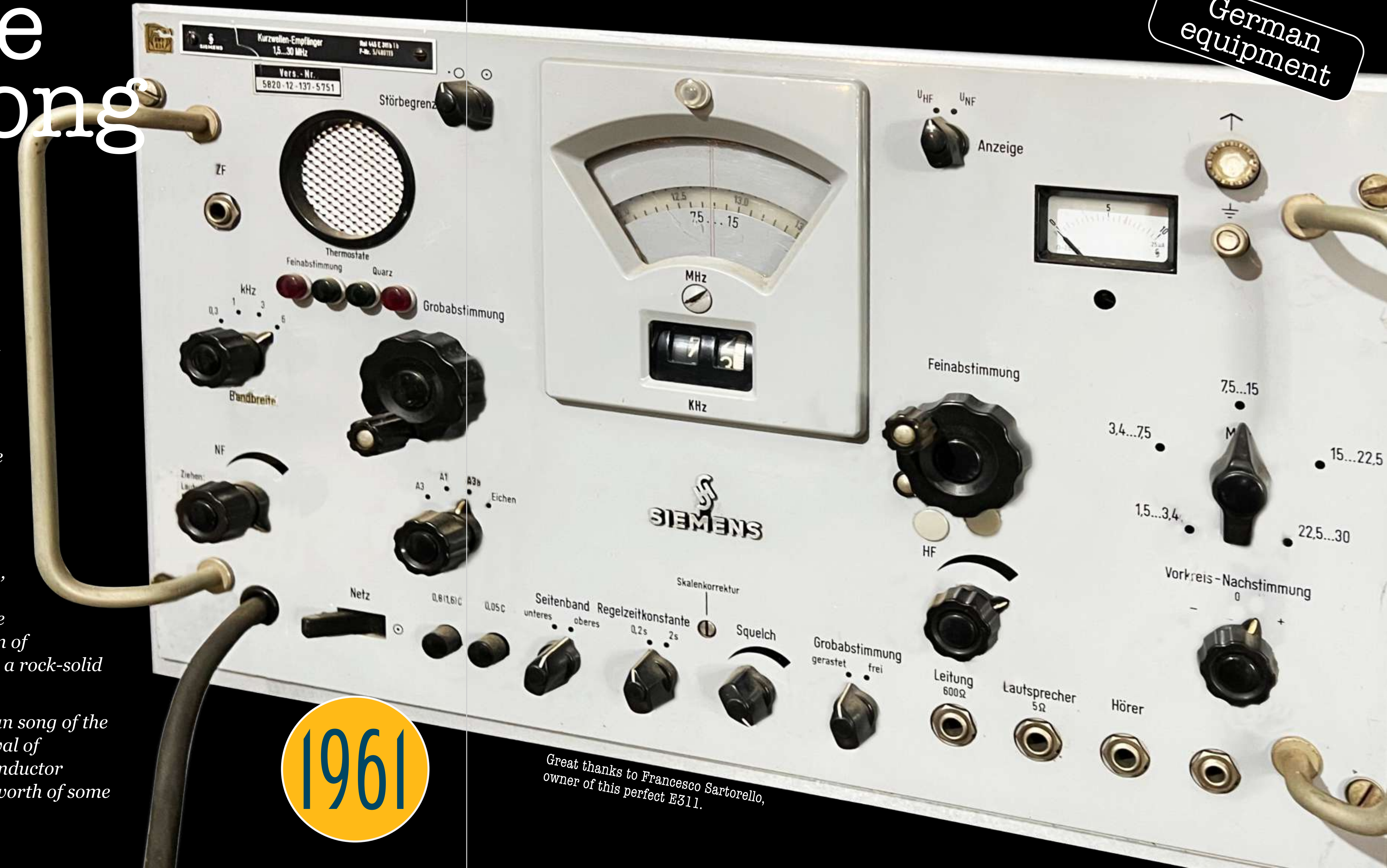
E311, the swan's song

Second designed after after the E309, the E311 receiver was one of the last and most fascinating professional receivers using tubes.

*While Collins was still proposing its old R390, E311 introduced novelties that will be the design standard in the following year, with an exceptional **Phase Locked Loop** oscillator, which allows to use it in two different modes, just flipping a knob.*

*E311 can be as easy to use as the old family receiver, with just one big knob to turn to quickly scan a broad range of frequencies. But just set the "gerästet" switch ("locked") and set the Grobabstimmung knob to the lower 100 kHz multiple of the frequency you want to receive. A lamp stop to blink and says that the **Raster Oscillator** is in the locked status. A second knob, with an odometer-type display, controls the **Interpolation Oscillator** and allows to explore the 100kHz segment with the incredible resolution of 100Hz (the R390 was still at one half of that) and a rock-solid stability.*

E311 was probably then the status-of-art, the swan song of the tube technology, destined to succumb to the arrival of semiconductor devices (it has inside some semiconductor device too). For this reason, I believe that it was worth of some extra pages in this booklet.


Kurzwellen-Empfänger
1,5...30 MHz
SIEMENS
Vers.-Nr.
5820-12-137-5751
Störbegrenz
ZF
Thermostate
Feinabstimmung
Quarz
kHz
0,3
1
3
6
Grobabstimmung
Bandbreite
NF
A3
A1
A3b
Eichen
MHz
KHz
SIEMENS
Netz
0,8(1,6)C
0,05C
Seitenband
unteres
oberes
Regelzeitkonstante
0,2s
2s
Skalenkorrektur
Squelch
Grobabstimmung
gerastet
frei
UHF
UNF
Anzeige
Feinabstimmung
7,5...15
3,4...7,5
15...22,5
1,5...3,4
22,5...30
HF
Vorkreis-Nachstimmung
0
–
+
Leitung
600Ω
Lautsprecher
5Ω
Hörer

1961

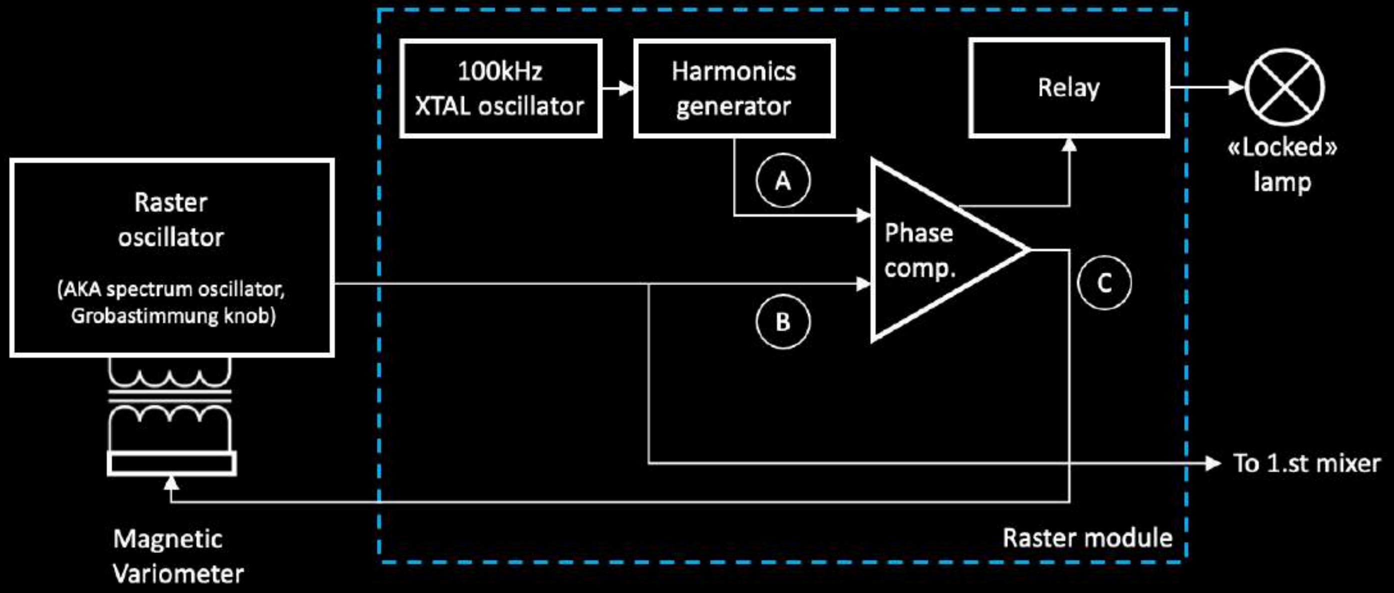
Great thanks to Francesco Sartorello, owner of this perfect E311.

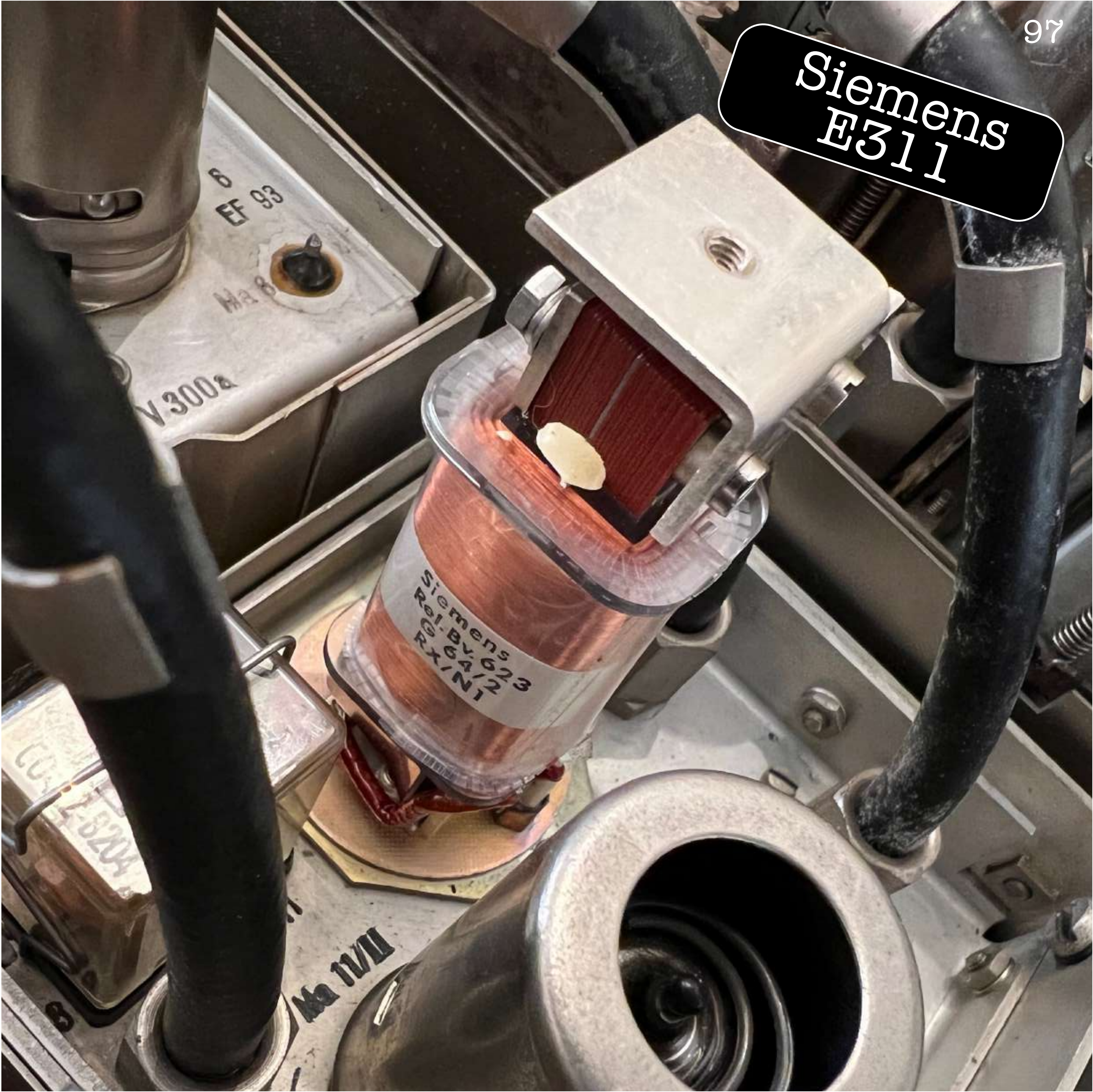
The Magnetic Variometer

How does it work the gerästet ("locked") mode, we described on previous page? In a way that is furthermore reasonably simple. To understand the circuit, we must introduce a component, that was new to me: the Magnetic Variometer (photo on the right). It is a four-pin component, similar to a transformer. A variable AC current on the primary, changes the inductance value of the secondary. This allows the E311 to control the frequency of an oscillator and thus to lock it to a stable reference signal. In few words:

- *a very stable, crystal controlled, 100kHz-oscillator is connected to a distorter, which produces harmonics up to 30MHz and above;*
- *this signal ("A") is mixed with the Raster oscillator (Grobabstimmung knob) ("B").*
- *In the mixing, we have the 100kHz A-signal and the x MHz B signal. When B is near to a 100kHz, a phase-difference C signal is generated. This C signal is used to control the B frequency by mean of the Magnetic Variometer, thus locking it to the phase of the 100kHz signal.*

There is also a "search circuit". Its purpose is to make easier the receiver's use. The PLL with the the Magnetic Variometer has a "capture range" limited to few kHz. This require attention to catch the right locking point. If something drifts, or when you switch off and on the receiver, you should again fine tune the Grobabstimmung knob to get the receiver again locked. So, the genial Siemens designers invented a simple but effective circuit that can "explore" the neighbours of the oscillator frequency to try to catch again the lock. This search circuit use just one relay and with some tricks produces a voltage, from negative to positive, that explore few kHz near the base frequency. If we are near to the locking frequency, we lock to it. Very simple and... and it works!


100kHz XTAL oscillator
Harmonics generator
Relay
«Locked» lamp
A
Raster oscillator
(AKA spectrum oscillator, Grobastimmung knob)
Phase comp.
C
B
To 1.st mixer
Magnetic Variometer
Raster module


6
EF 93
Ma 8
V 300a
Siemens
Rel.Bv.623
GS 64/2
RX/N1
Ma 11/II

Siemens E311

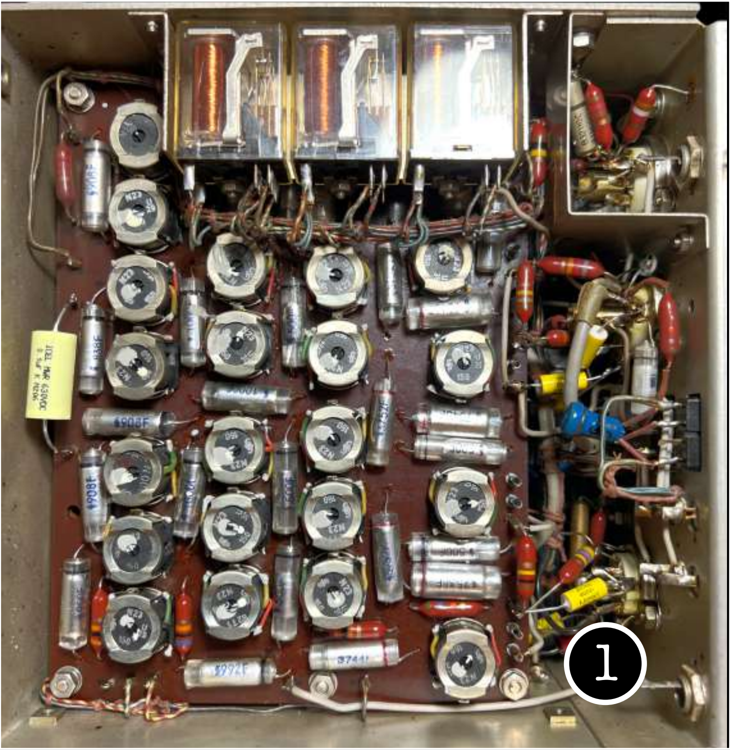
A modular approach

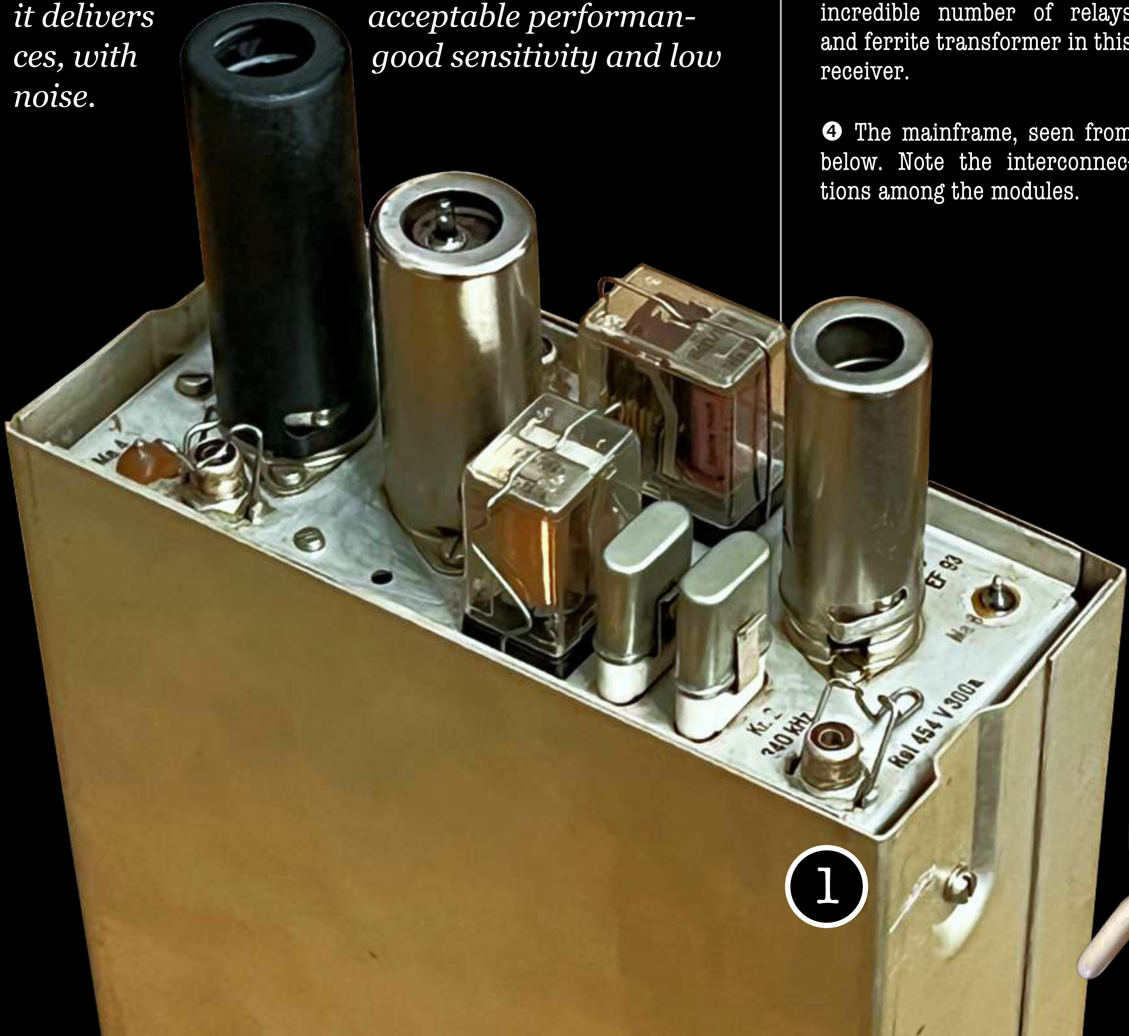
In the sixties, Siemens was very dynamic and innovative with its "300 series" of receivers. If you compare the pictures in these pages with the E309, there is no doubt, the E310 internals give less emotions respect to its ancestor. E309 is more rational, with a modular structure, easier to manage respect to the Collins R39x series or to the almost monolithic Racal RA.17.

Most modules are plug-in and easy to remove. Also mechanically-involved modules, like the Interpolation Oscillator, are not difficult to extract and insert back.

The radio frequency is passed from one module to another with very practical coaxial connectors, which allow furthermore to easily observe and analyse signals.

E311 had triple conversion and is designed also to receive SSB. It was rather power-hungry, with 16-tubes requiring more than 70W and 30 more for the crystal heaters. Still today it delivers acceptable performances, with good sensitivity and low noise.



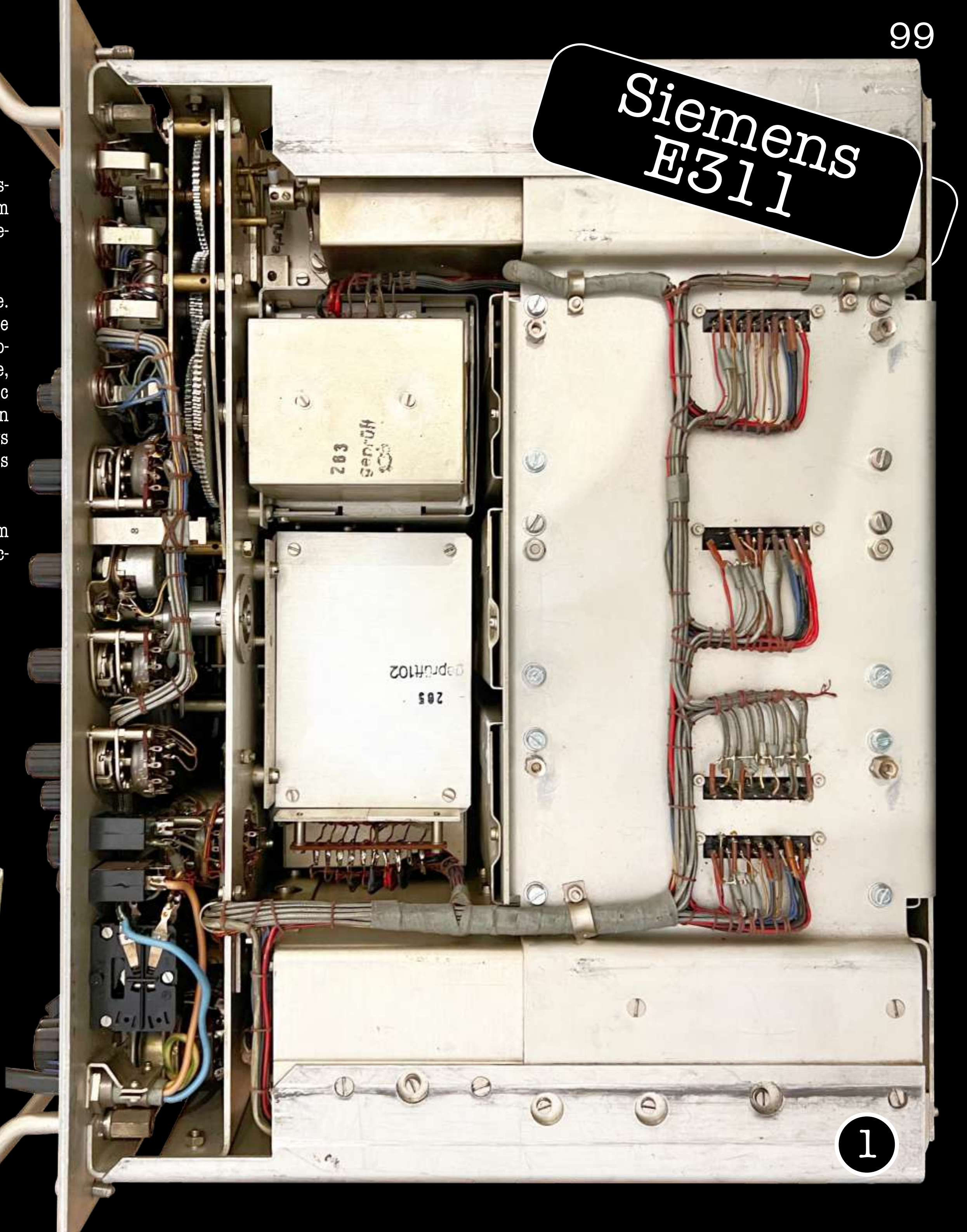


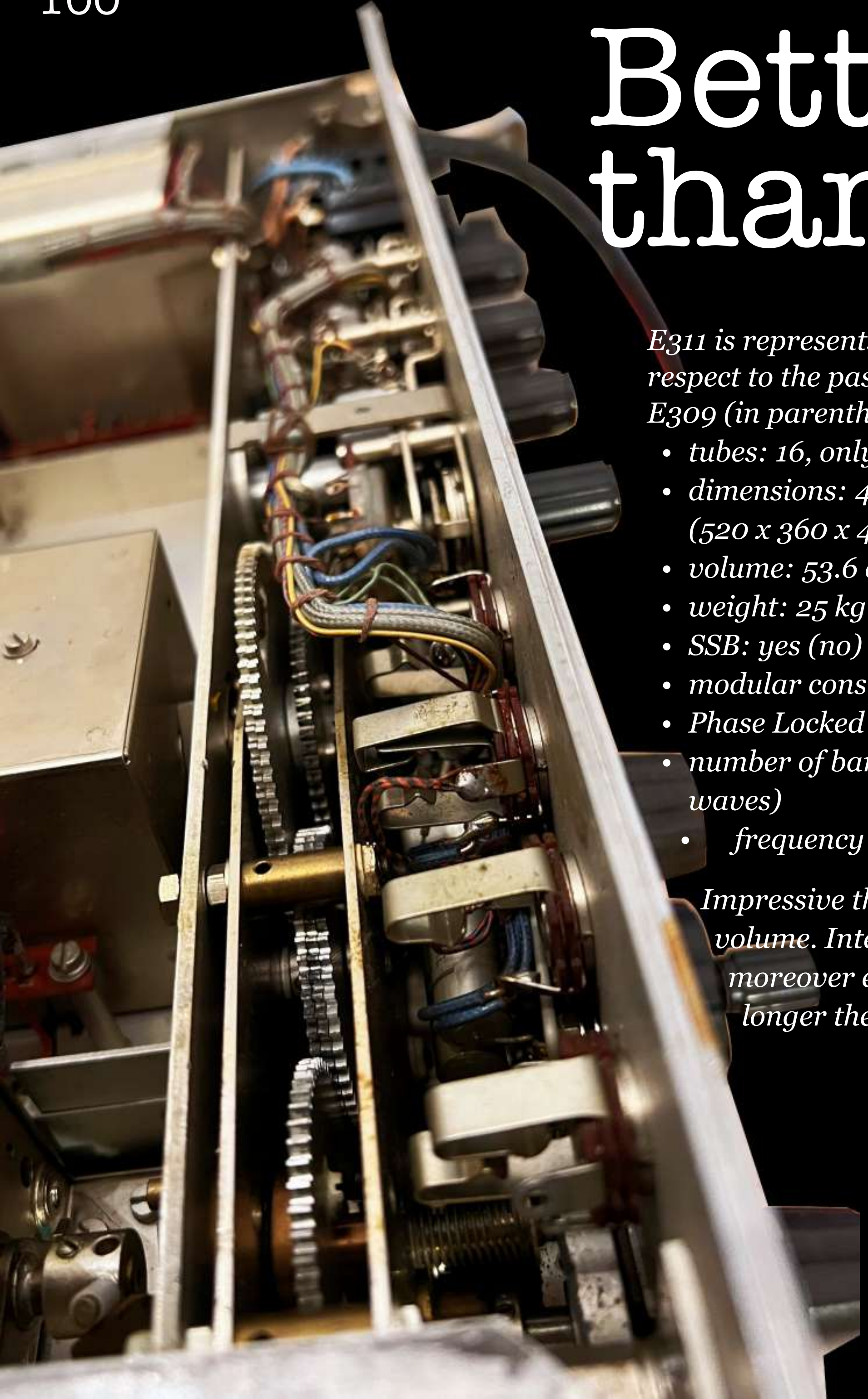
Siemens E311

❶ One of the modules composing the E311. Most of them can be easily and quickly removed.

❷ The interior of a module. Note the presence of the Printed Circuit Board, an absolute novelty at that time, which changed the electronic industry for ever. There is an incredible number of relays and ferrite transformer in this receiver.

❹ The mainframe, seen from below. Note the interconnections among the modules.





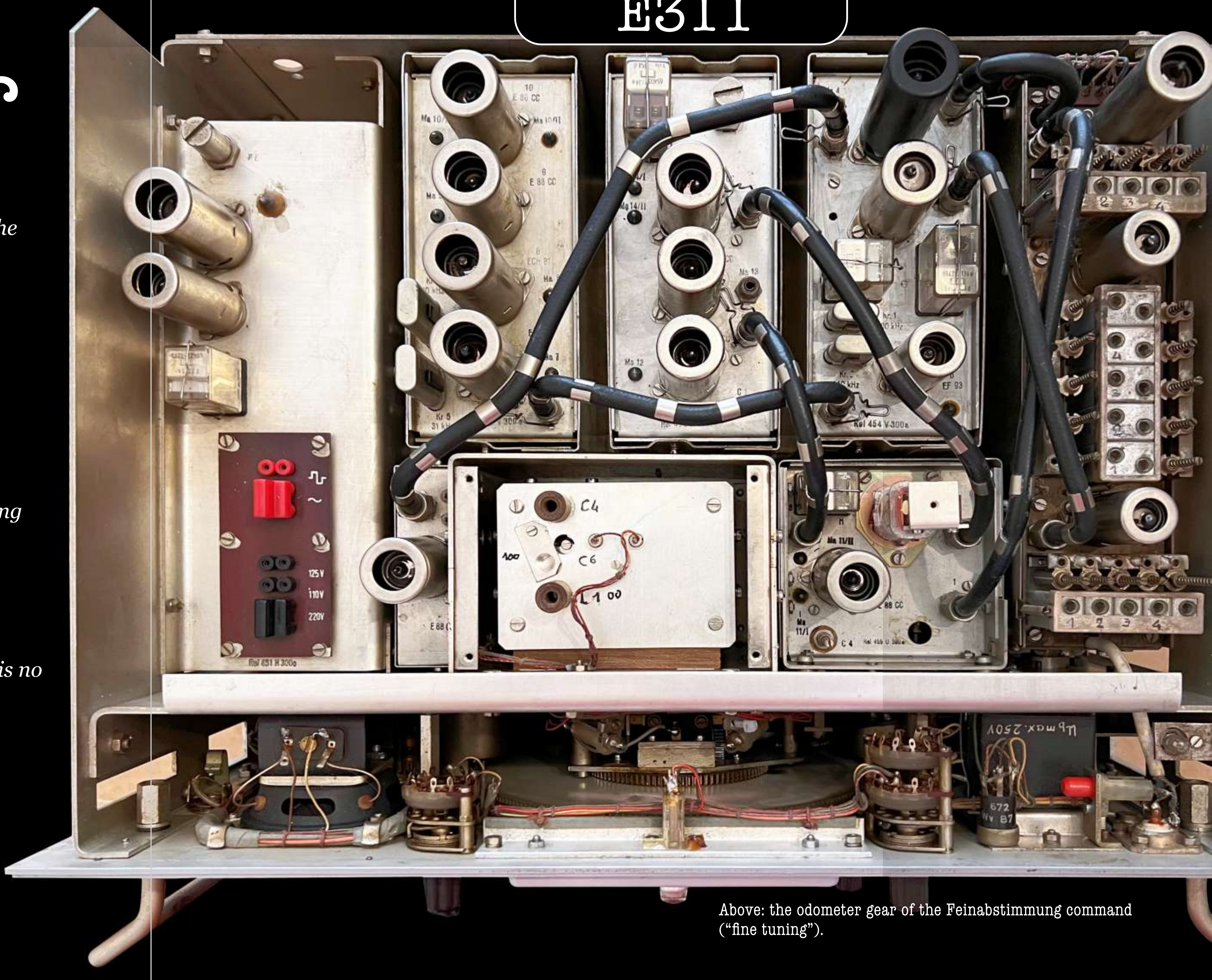
Better than ever

E311 is represents a significant improvement respect to the past. Let's compare E311 with the E309 (in parenthesis):

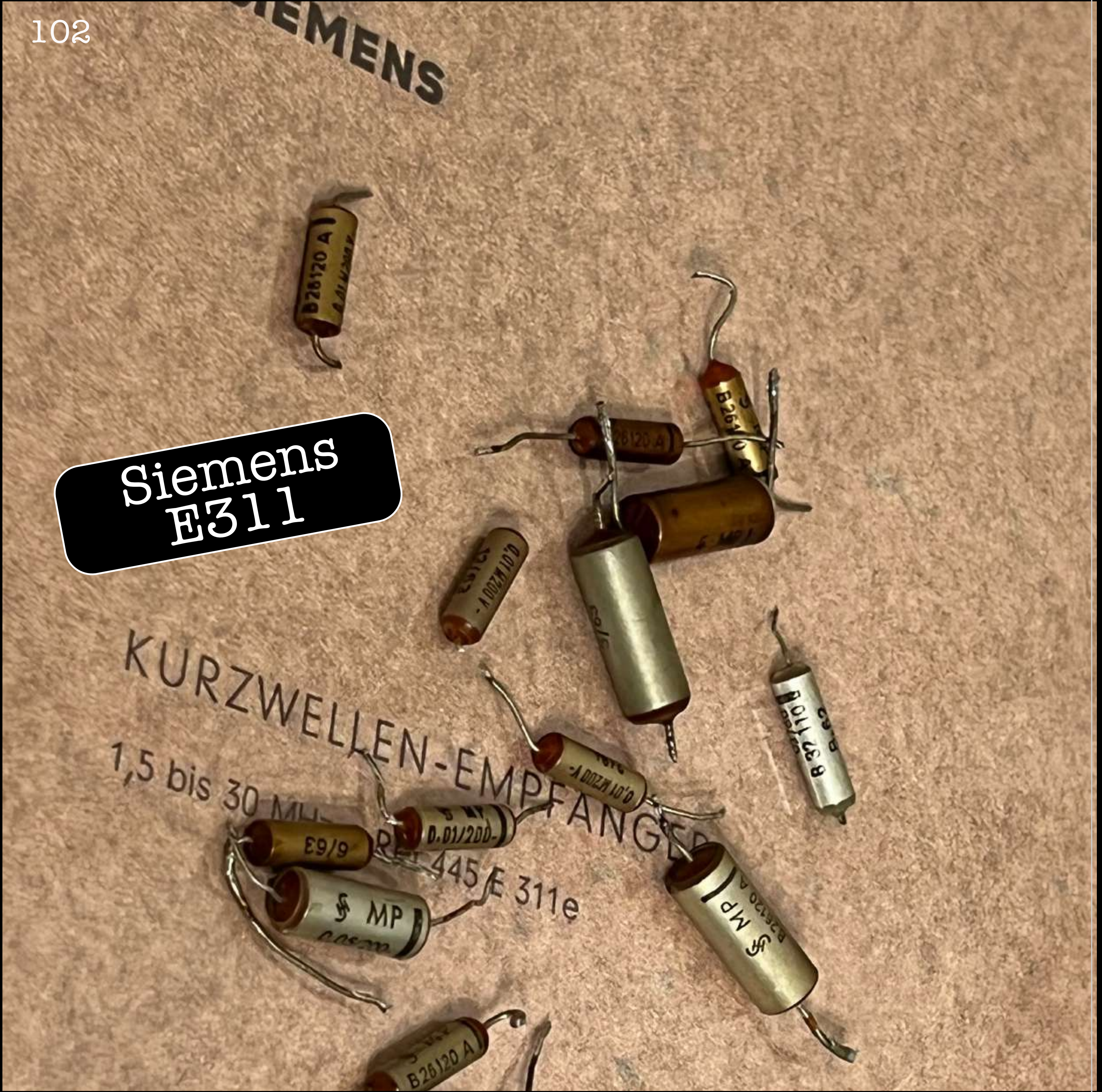
- *tubes: 16, only of 3 types in total (14)*
- *dimensions: 471 x 291 x 391 mm (520 x 360 x 410)*
- *volume: 53.6 dm3 (76)*
- *weight: 25 kg (38)*
- *SSB: yes (no)*
- *modular construction: yes (not)*
- *Phase Locked tuning: yes (not)*
- *number of bands: 5 (7, but E311 has not long waves)*
- *frequency resolution: 100Hz (1,000)*

Impressive the difference in weight and volume. Interesting also that E311 is moreover easier to operate; e.g., there is no longer the BFO frequency control.

Siemens E311



Above: the odometer gear of the Feinabstimmung command ("fine tuning").



60 years later

Sixty years (1961-2022) is much more than original expected life of a radio receiver. According today's standards, any year exceeding the expected life represents extra costs that you gave for free in your production process. The ideal product lasts exactly as long as the expected life, and then dissolves in a cloud of smoke.

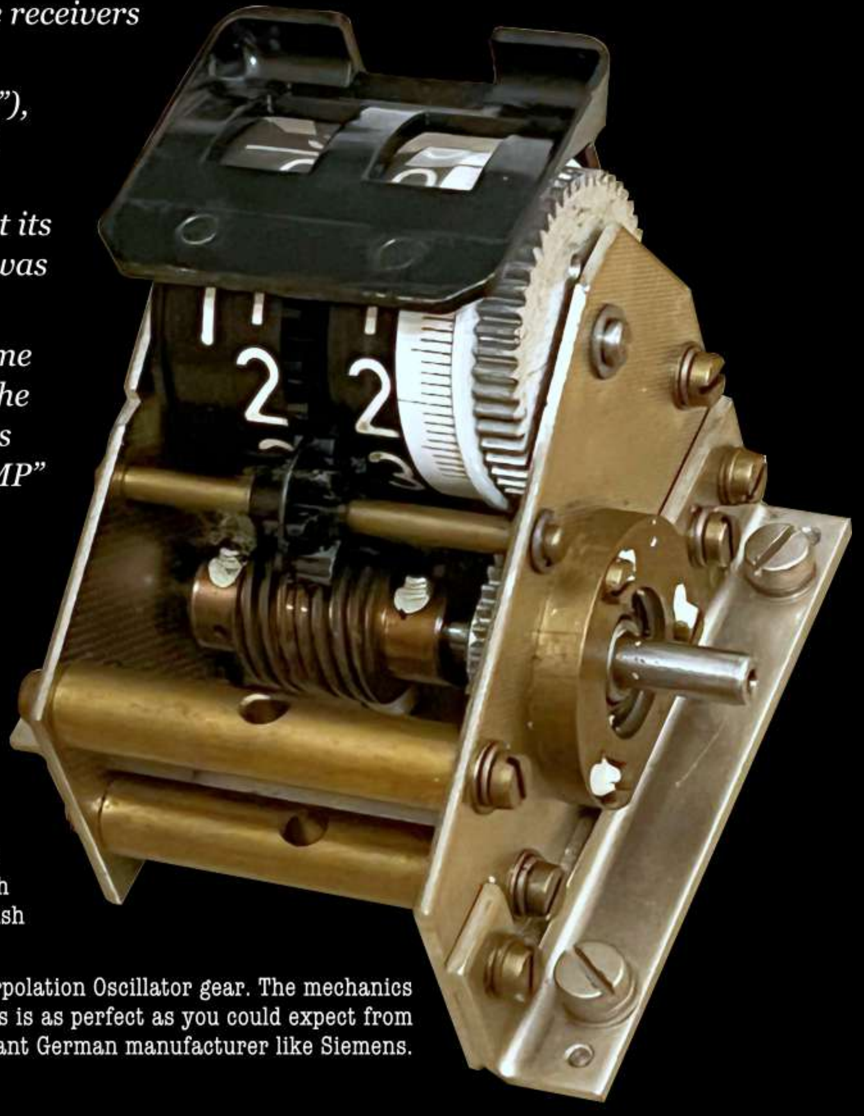
In Siemens (and not only there), they had not exactly this idea, and so, after more than 60 years, these receivers are often almost in conditions like new.

In my case, I bought a 1964 E311 (version "b"), and it was not working properly: the locked mode was not operating and the Feinabstimmung oscillator (here on the right its gear) stopped working when the frequency was below 30 on the display.

Both the problems turned out to have the same origin, two faulty MP capacitors (photo on the left). They are indicated on the schematics as MKL or MKH, but really they are marked "MP" on their body. The problem is not that they leak, as I was used to find, but that they change their value or loose all their capacity (down to few pF). My suggestion is that you change them all systematically.

All the rest is my receiver in excellent conditions. I could not find a resistor that drifted its value.

If you want to read the whole story of my E311's repair, you can download it from the Photo Parade web page, together with many photos, the original manuals in German and some English translations of them.

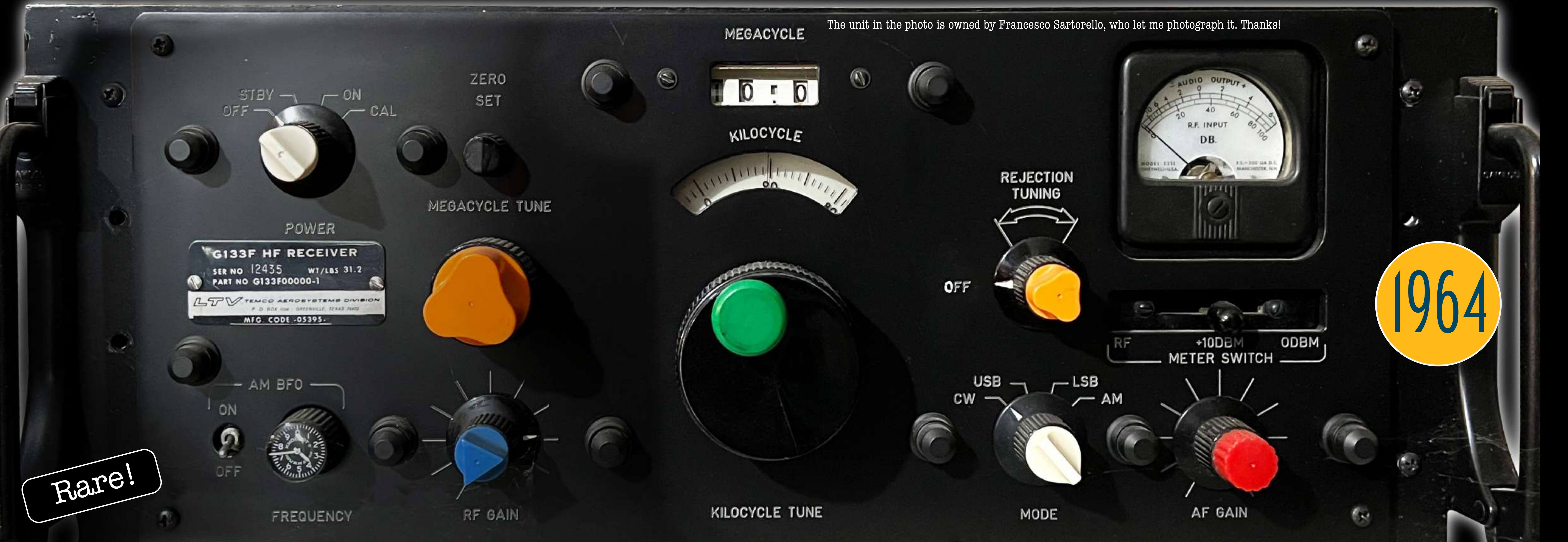

Above: the Interpolation Oscillator gear. The mechanics of these receivers is as perfect as you could expect from an important German manufacturer like Siemens.

What's is this?

I must to be sincere: when I photographed it at Francesco's, I thought it was a Racal RA.217, that is completely different, confirming that I am not a surplus expert. But may be that not everybody is able to tell at a glance what it is. I want to help you: it's by Collins...

G133F, that is its name, is essentially a Collins 51-S-1 receiver, but... modified in 1964/65, at the request of the US Air Force, by the LTVTEMCO AEROSYSTEMS DIVISION. The modifications consist of both mechanical variations and circuit additions, in particular: ***a)*** *a different front panel and different knobs;* ***b)*** *an enclosure to reduce EM emission, to avoid radio localisation by the enemy;* ***c)*** *two new semiconductor sub-chassises for the BFO and for interfacing an external digital frequency display;* ***d)*** *a transistorised converter to allow the 200 kHz - 2 MHz reception;* ***e)*** *the removed tune lock knob. The G133F was used on reconnaissance aircraft or for special operations, in particular it is certain that it was installed on U-2 spy planes.*

There are many things to say on this interesting unit, I got the above information from this very good article: http://www.radiomanual.info/schemi/Surplus_NATO/LTV_G-133F_review_IT_2001.pdf, by Federico Baldi; unfortunately this article is available in Italian only.


MEGACYCLE
STBY
ON
OFF
CAL
ZERO SET
KILOCYCLE
MEGACYCLE TUNE
POWER
G133F HF RECEIVER
SER NO 12435
WT/LBS 31.2
PART NO G133F00000-1
LTV TEMCO AEROSYSTEMS DIVISION
MFG CODE -05395-
AUDIO OUTPUT
R.F. INPUT
DB.
REJECTION TUNING
OFF
RF
+10DBM
ODBM
METER SWITCH
AM BFO
ON
OFF
USB
LSB
CW
AM
FREQUENCY
RF GAIN
KILOCYCLE TUNE
MODE
AF GAIN

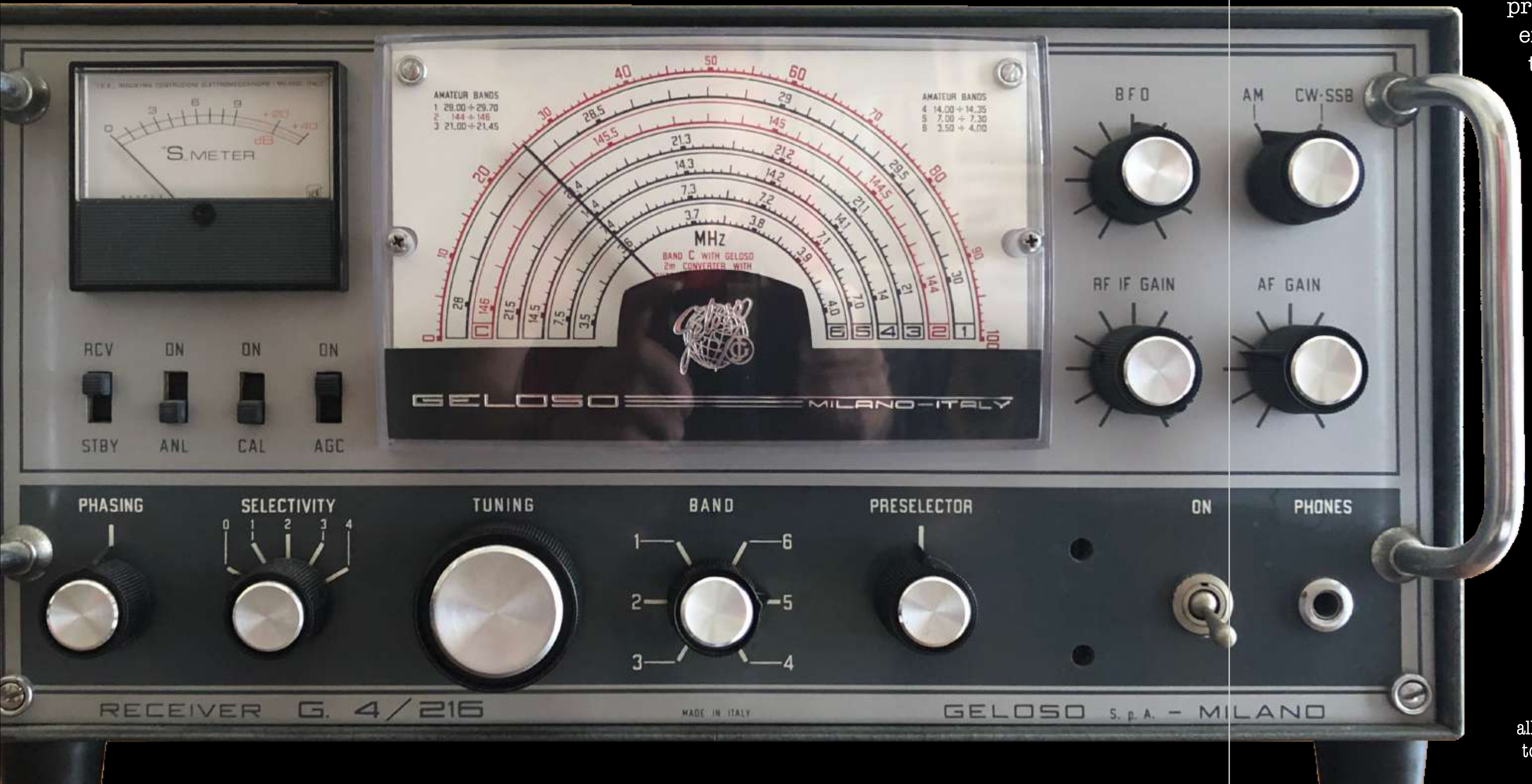
The unit in the photo is owned by Francesco Sartorello, who let me photograph it. Thanks!

Rare!

1964

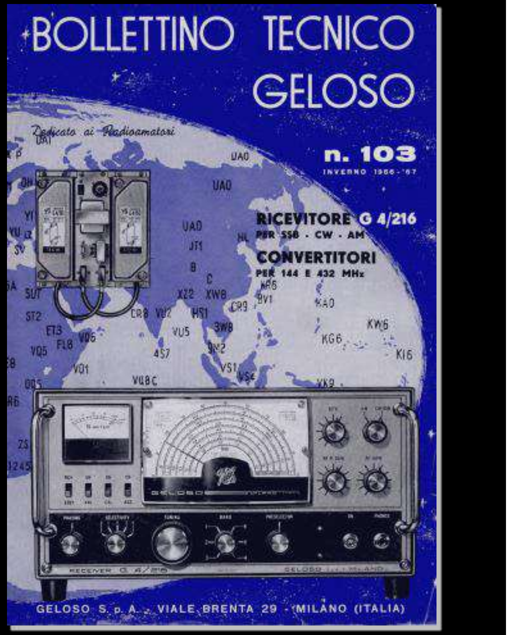
Geloso G4/216

Geloso was the Italian company producing radios, televisions, acoustic amplifiers, amateur receivers, magnetic recorders, audio devices and electronic components, founded in 1931 by Giovanni (John), an Italian-Argentinian entrepreneur. Geloso was one of the large and glorious companies, that we Italians are very clever at destroying. In 1972 it was definitely closed.


S.METER
BFO
AM
CW-SSB
RF IF GAIN
AF GAIN
RCV
ON
ON
ON
STBY
ANL
CAL
AGC
MHz
GELOSO MILANO-ITALY
PHASING
SELECTIVITY
TUNING
BAND
PRESELECTOR
ON
PHONES
RECEIVER G. 4/216
MADE IN ITALY
GELOSO S.p.A. - MILANO

Why do I speak of it, so? Yes, it is not military surplus but it has been so important for me that, when I was forced to sell my previous collection, I decided to keep anyway this G4/216 receiver, along with the WS 19, the BC-221 and an old R-107 British receiver (and a couple of Geloso magnetic recorders).

What follows is the description taken from the "Bollettino tecnico Geloso N°103" of winter 1966-1967 (see it on the right):



BOLLETTINO TECNICO GELOSO

Dedicato ai Radioamatori

n. 103

INVERNO 1966-'67

RICEVITORE G 4/216 PER SSB - CW - AM

CONVERTITORI PER 144 E 432 MHz

GELOSO S.p.A. - VIALE BRENTA 29 - MILANO (ITALIA)

"Derived from previous radio amateur communication receivers produced by GELOSO, the G 4/216 is designed with the intention of offering to transmitting amateurs a set of professional quality, designed to operate exclusively on the frequency bands allocated to their use. When planning this receiver, certain feature of primary importance were particularly considered; e.g., stability vs. time and accuracy of the calibration, sensitivity and signal-to-noise ratio, possibility to clip noise interference (noise limiting), possibility to choose the audio (beat) note at will (accomplished by means of a beat frequency oscillator operating at the intermediate frequency). In addition, this receiver is capable of receiving amplitude modulated signals and c.w. signals as well as single-side-band-suppressed carrier (s.s.b.) signals."

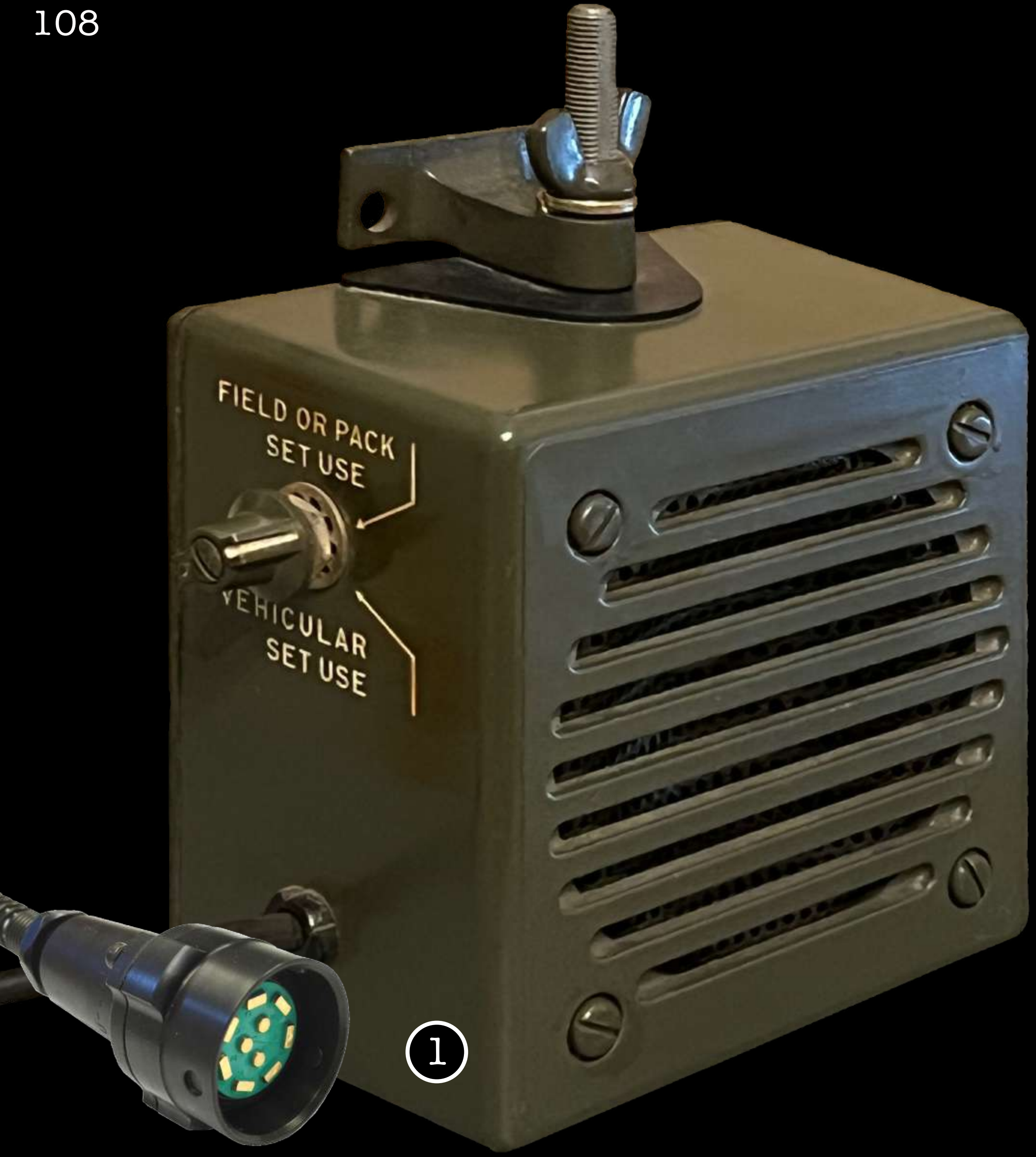
Reasonably priced but not cheap, with tis good price performance ratio, it was the king receiver for lot of amateurs. Still today has very good performances and ease of use.

Here on the right, the original wooden box of my G4/216, that I conserved for all these years, could be today considered too expensive for this kind of equipment.

7630
ALTO
WITH CARE
FRAGILE
Geloso
MADE IN ITALY

1967

Italian equipment



①

Human interfaces

Besides the front panel, the most important user interfaces of receiver and transmitters are loudspeakers, microphones (and keys for telegraphy, if you like).

It's incredible how much the transducer technology has been improved in the last years, due probably to the smartphones requirements. Today, even the cheapest mobile phone has a loudspeaker inside, capable to reproduce music at a good level of sound intensity and quality.

Many years ago, things were much different and a decent quality of the sound was not common at all. The LS-3 speaker, probably the most common in WW2, weights some kilograms and has a terrible quality (now even worse, due to the years). The LS-454, very common in the fifties, can be also submerged, but, even without the water, has a sound really not good. The M-29/U microphone is not better.

But I love them anyway...

❶ LS-454 loudspeaker

❷ LS-3 loudspeaker

❸ TM-29/U handheld microphone

②

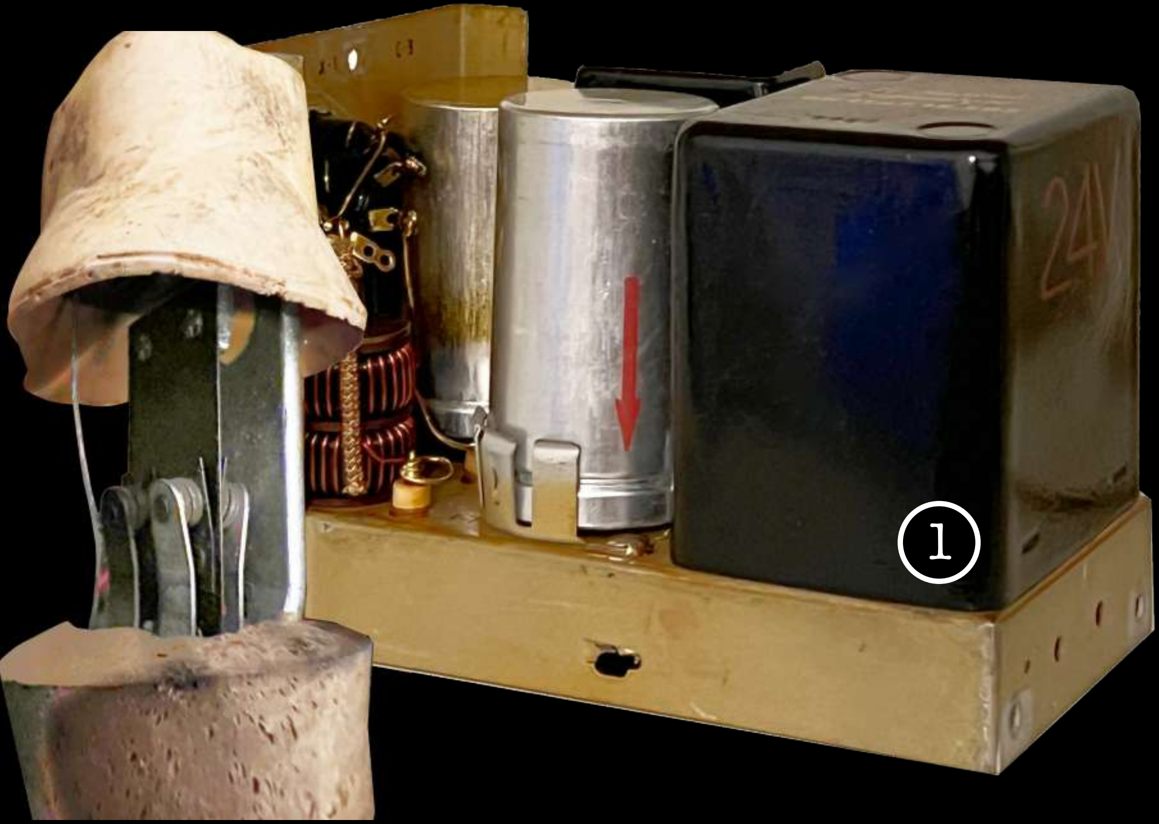
③

Good vibrations

In the old times, you normally required high voltages for tube plate, but you had available only low voltage Pb batteries (or the dynamo of a vehicle). That made very difficult to create portable equipment.

Formerly, most of portable equipment used ***dynamotors****, a mechanical assembly composed by an electric motor moving a dynamo, which produced all the high voltages required for a specific device. We already spoke of that, talking of the T-195 transmitter, whose dynamotor is a black beast, requiring a lot of current, especially for the start-up. Later, it was replaced with a solid state inverter, with germanium transistor. I had to work hard on it, to replace those transistors, that were neither no longer good nor available (see the photos).*

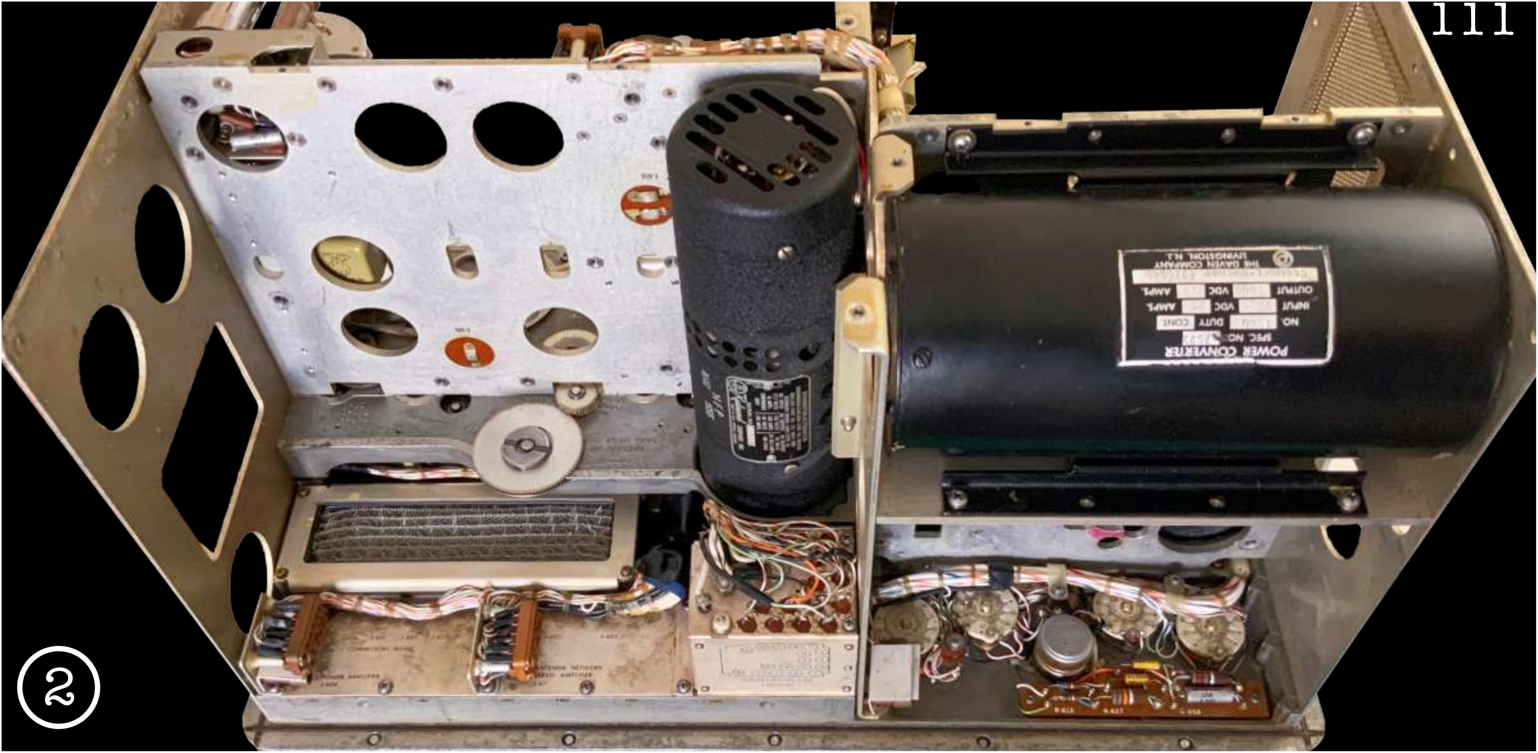
Eventually, i.e. after the war, most of the equipment used instead a vibrator-type inverter. The vibrator is just an automatic switch that converts the DC in AC, which, with a suitable transformer, produces the required voltages. With today eyes, it could seem rather precarious, but it worked well and reliably.

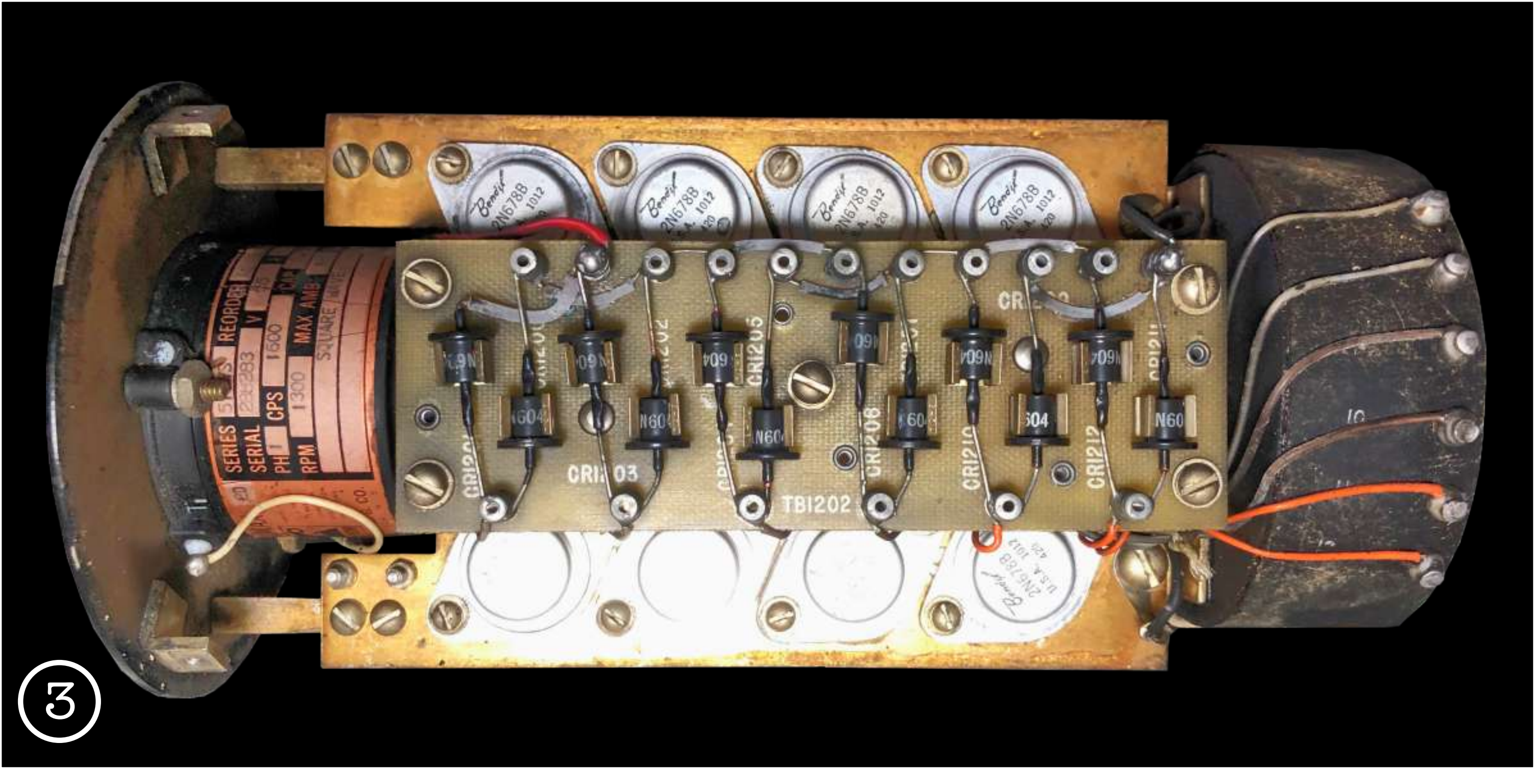


① This module, called PP-282, is a normalized vibrator power supply used on many different devices, such as the RT-70 or the R-108-9-10 receivers. Other models (PP-281 and PP-448) allowed the operation at 12 or 6 V instead of 24. The vibrator itself is the silver cylinder with the red arrow; in foreground, you can see it without its case. Although normally reliable, vibrators tend to oxide when not used, and stop working. I learnt that they can be opened with a cutter, cleaned and re-closed easily enough. In this way I have repaired several of them.

② The T-195 dynamotors. The bigger is for high voltage, the smaller produces various voltages, including the 115V 400 Hz AC for the servo motors. From outside, the real dynamotors are similar to the more recent solid state models.

③ The T-195 solid state dynamotor required me a lot of work to be understood and restored.

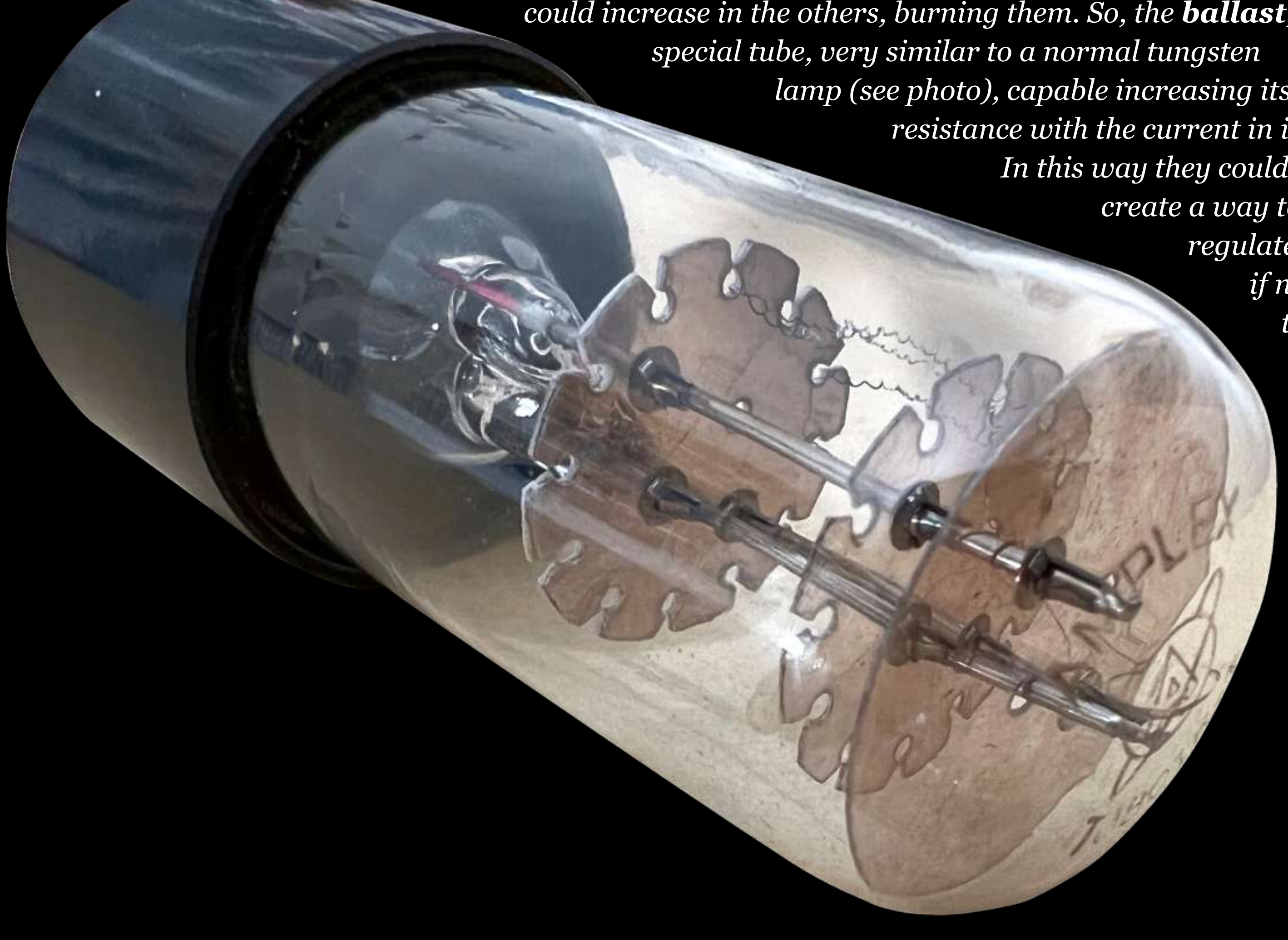


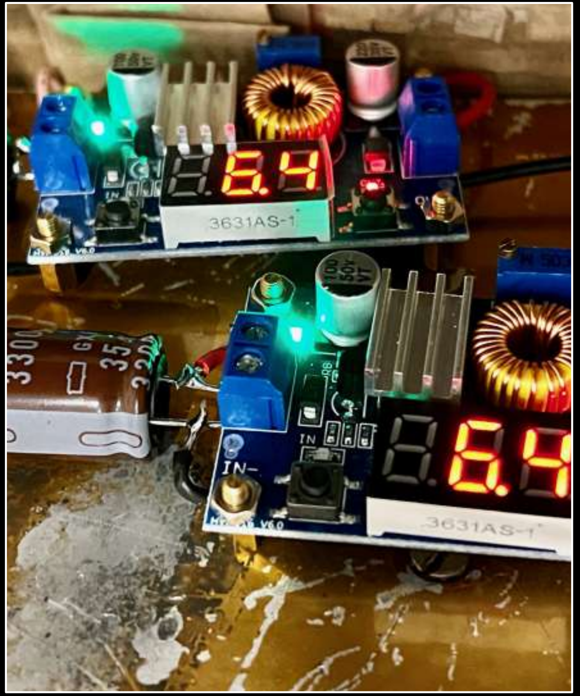


Poor filaments!

Producing a stabilised tension for the tubes' filaments: today it seems easy, just use a voltage regulator, better of the switching type. But, at that time, they had no integrated circuits and the problem was not easy to solve, especially in portable equipment, that hasn't an AC transformer.

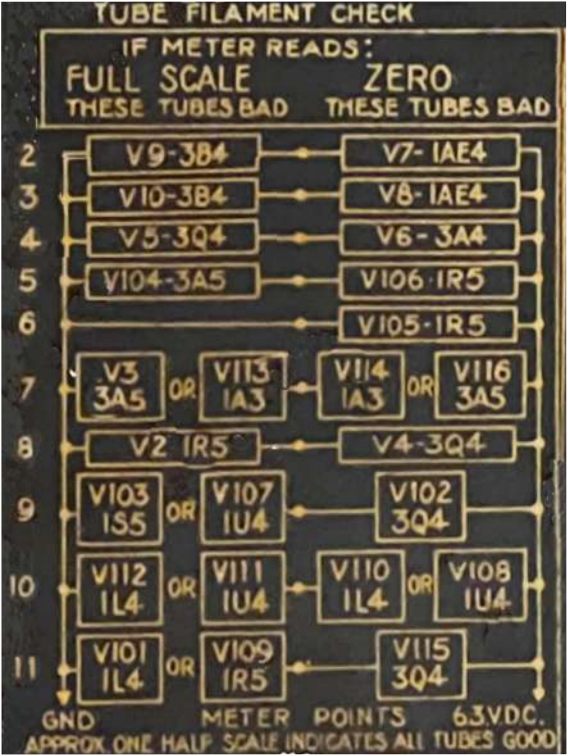
The standard solution in the fifties was combining the filaments in series/parallel, so that they, together, met the available battery voltage. But, clearly, that method was by itself dangerous: besides supply fluctuations, if a filament broke, the current could increase in the others, burning them. So, the ***ballast****, a special tube, very similar to a normal tungsten lamp (see photo), capable increasing its resistance with the current in it. In this way they could create a way to regulate, if not the voltage, at least the current. That was however not enough, and they were forced to add another special device, the* ***thermal relays****, externally similar to a tube, capable of switching off in case of an excessive voltage increase.*





In the case of the RT-66 (67 and 68), a switch was added on the front panel, to allow checking the filaments. The system was eventually rather simple (see the photos). You had to check all the various switch positions and, for each of them, the meter should remain in the red zone. If not, you should open the box, find inside the table that you can see below on the left, and decode which tube was wrong, according to the reading (zero or full scale).

I confess that I modified a PP-112 power supply (in a reversible way, obviously!) with a couple of wonderful 10$ switching power supplies by Amazon, after a small catastrophe repairing my RT-68... see the photo here on the left.



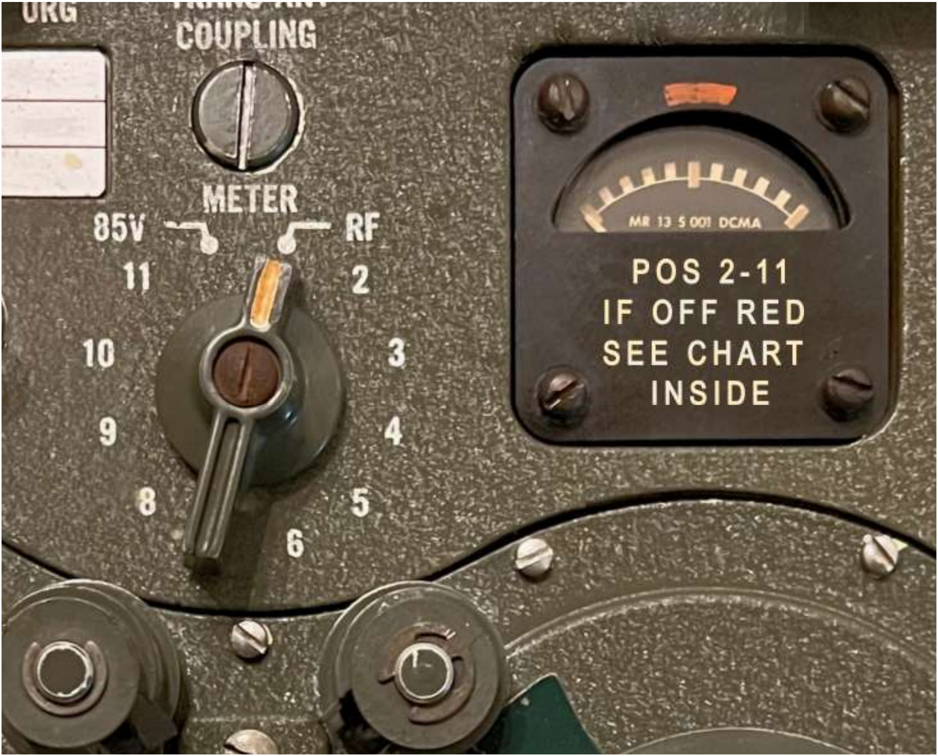
TUBE FILAMENT CHECK

IF METER READS:

	FULL SCALE THESE TUBES BAD	ZERO THESE TUBES BAD
2	V9-3B4	V7-1AE4
3	V10-3B4	V8-1AE4
4	V5-3Q4	V6-3A4
5	V104-3A5	V106-1R5
6		V105-1R5
7	V3 3A5 OR V113 1A3	V114 1A3 OR V116 3A5
8	V2 1R5	V4-3Q4
9	V103 1S5 OR V107 1U4	V102 3Q4
10	V112 1L4 OR V111 1U4	V110 1L4 OR V108 1U4
11	V101 1L4 OR V109 1R5	V115 3Q4

GND METER POINTS 6.3V.D.C.

APPROX ONE HALF SCALE INDICATES ALL TUBES GOOD



Instruments

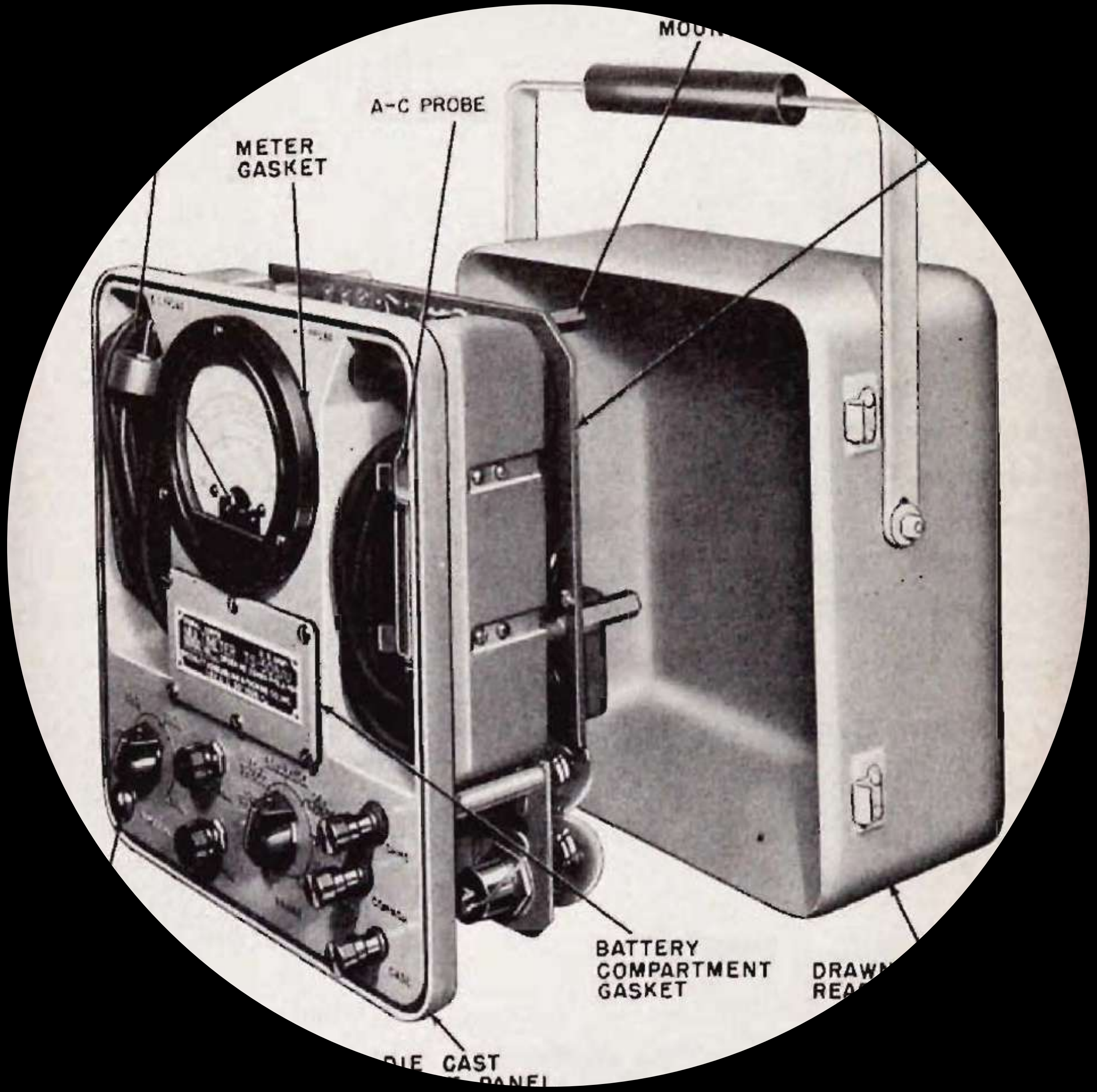
Technology *in general, and specifically electronics, has been always fascinating me, since when I was a boy. Furthermore, the* ***history of technology*** *allows us to better understand the today's one.*

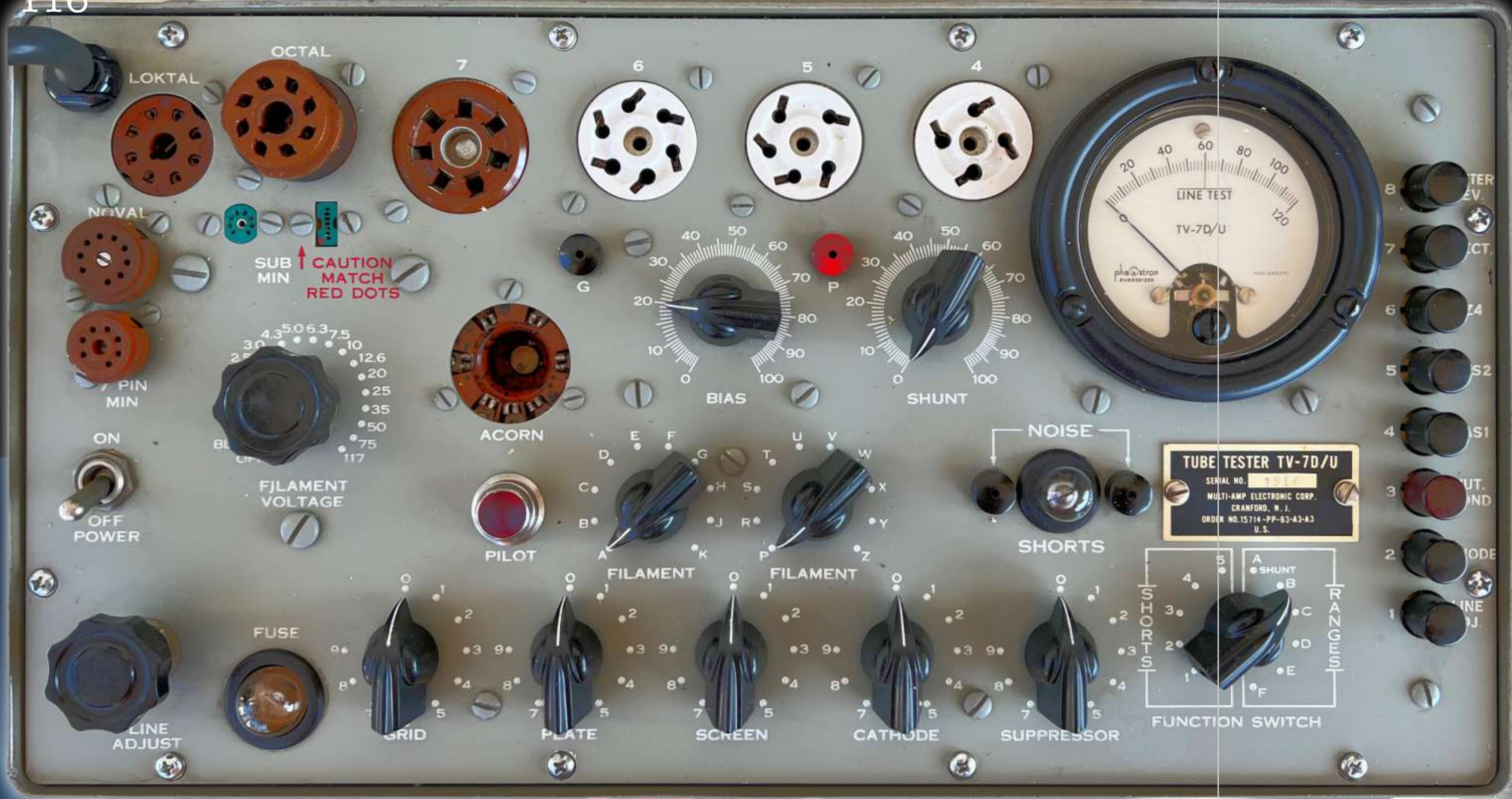
Having been an electronic designer for a long part of my life, I like to imagine the work of my predecessors, how could they do without all the "Computer Aided Something", essential nowadays, how they did get up in the night finding some ingenious solution to a complex problem they could not solve during the day, how much they loved the equipment that they were designing.

For these reasons, I am interested not only to surplus receivers and transmitters, but also to the instruments used for their design, tune-up and maintenance, the so called "Test Sets", even more intriguing.

Furthermore, in some cases, it is necessary to return back to old instruments, because simply does not exist today a modern equivalent of those old tools, and modern oscilloscopes or spectrum analysers are not always enough for our purposes.

And using old instruments to repair old equipment seems to me a greater amusement…




LOKTAL
OCTAL
NOVAL
SUB MIN
CAUTION MATCH RED DOTS
7 PIN MIN
ON
OFF
POWER
FILAMENT VOLTAGE
ACORN
PILOT
BIAS
SHUNT
LINE TEST
TV-7D/U
NOISE
SHORTS
TUBE TESTER TV-7D/U
SERIAL NO.
MULTI-AMP ELECTRONIC CORP.
CRANFORD, N. J.
ORDER NO.15714-PP-63-A3-A3
U. S.
FILAMENT
FILAMENT
FUSE
LINE ADJUST
GRID
PLATE
SCREEN
CATHODE
SUPPRESSOR
SHORTS
RANGES
FUNCTION SWITCH

A typical example, confirming the opinion expressed on the previous page, when we said that sometime it is not a choice to return back to old instruments, is the tube tester, because today does not exist a modern equivalent of it.

The tube tester allows us to understand if a tube is still good and capable to operate correctly. In these pages, one of the most appreciated tube tester: ***the wonderful TV-7/U*** *mutual conductance tester. Introduced in 1951, has been produced until 1982. Today is very requested also by hi-fi tube enthusiasts (those who have turned today very expensive a very common tube, like an ECC 82... but I am glad if tubes have now new friends).*

S102
R102
S106
S103
S107
E102
S104
R104

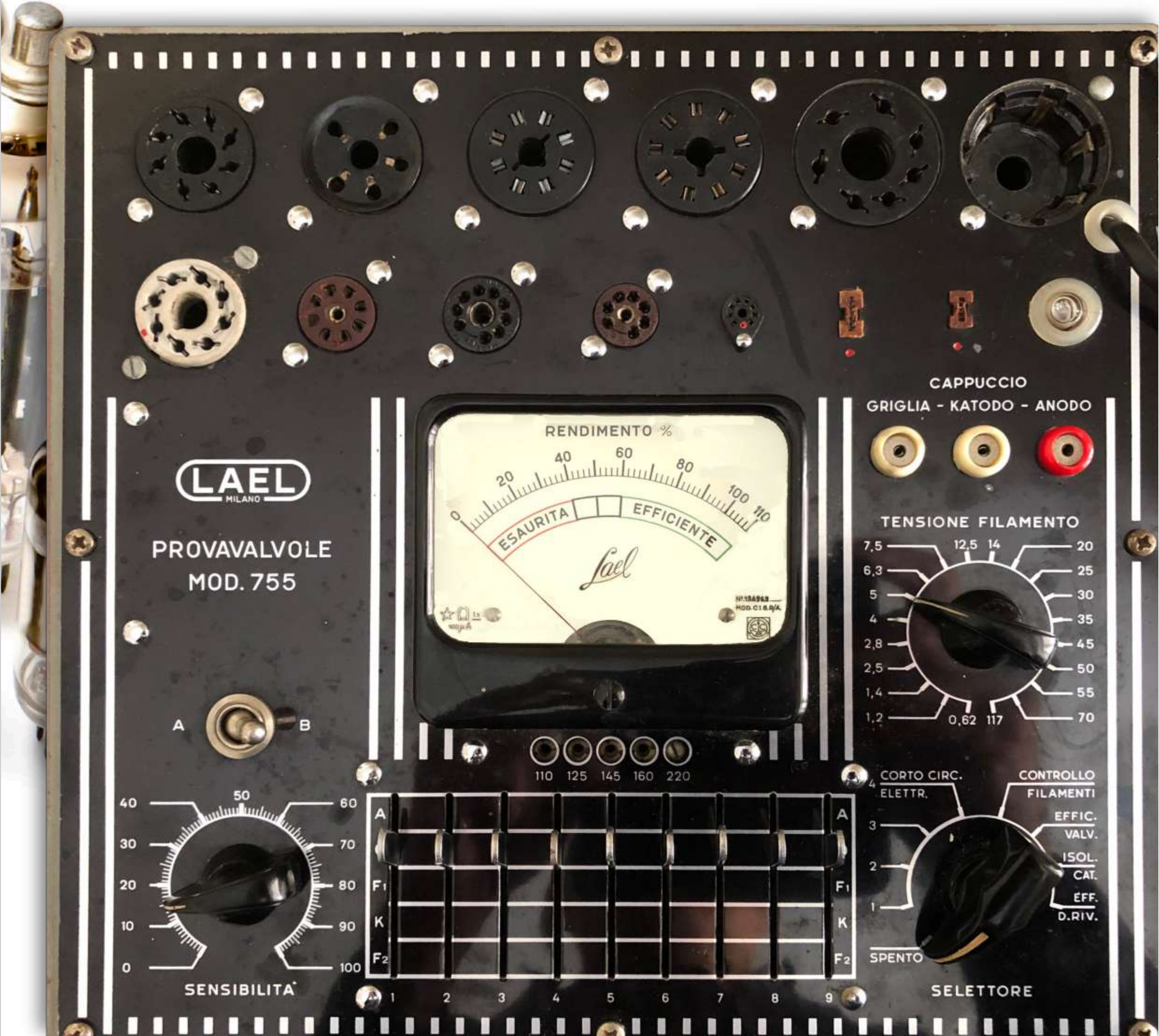
Testing them
TV-7/U tube tester

1951

In the picture on the right, the LAEL 755, an Italian tube tester, of the so-called "emission" type, cheaper but definitely inferior than those of the transconductance type, such as the previously seen TG-7/U. It basically treats any tube as a diode by connecting the cathode to ground, all the grids and plate to B+ voltage, feeding the filament with the correct voltage, with an ammeter in series with either the plate or the cathode. Many tube testers of that time were of this type.

1965?

Other tube testers

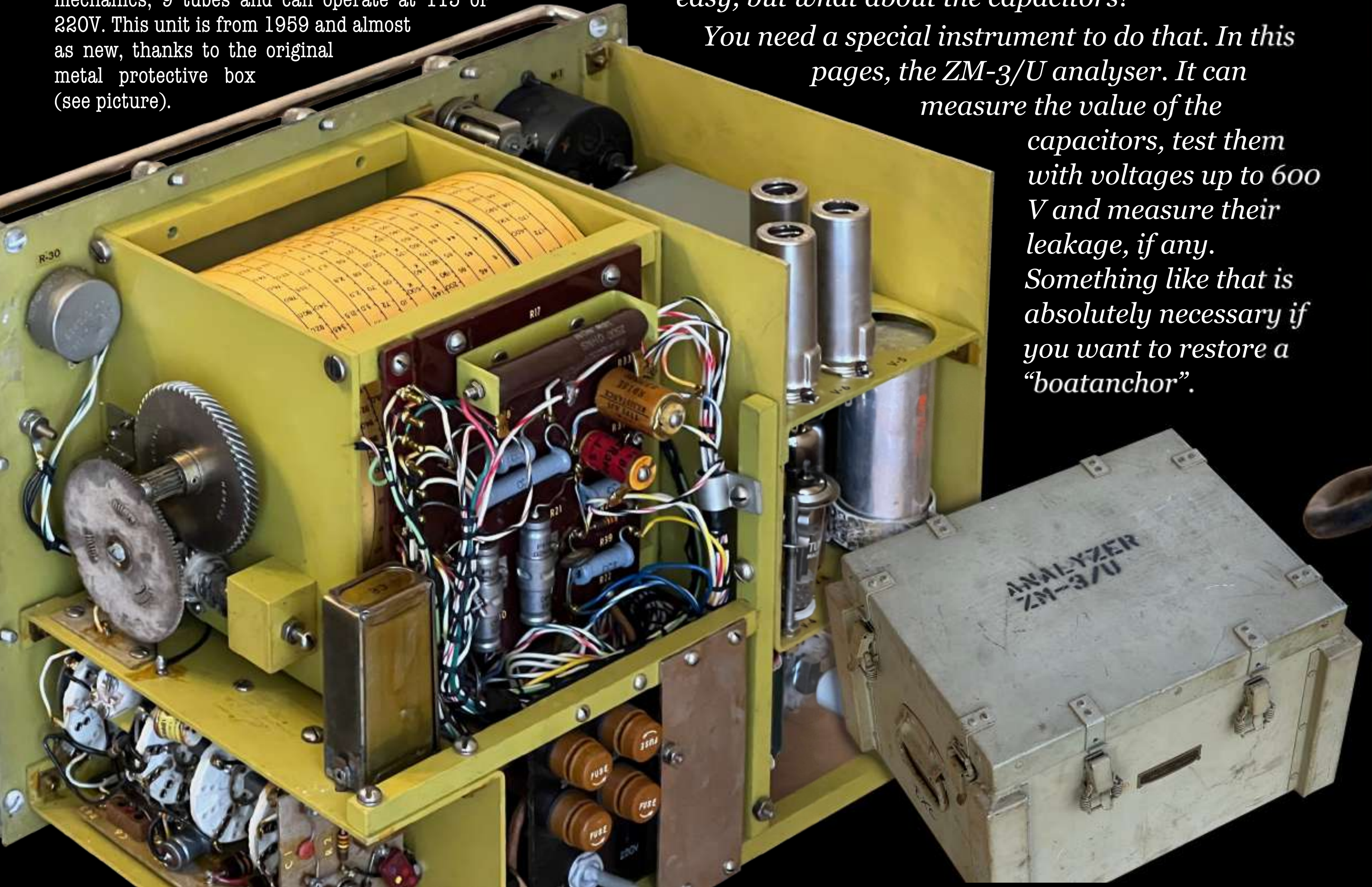

LAEL
MILANO
PROVAVALVOLE
MOD. 755
RENDIMENTO %
0
20
40
60
80
100
110
ESAURITA
EFFICIENTE
CAPPUCCIO
GRIGLIA - KATODO - ANODO
TENSIONE FILAMENTO
7,5
6,3
5
4
2,8
2,5
1,4
1,2
0,62
117
12,5
14
20
25
30
35
45
50
55
70
A
B
110
125
145
160
220
SENSIBILITA'
0
10
20
30
40
50
60
70
80
90
100
F1
K
F2
1
2
3
4
5
6
7
8
9
CORTO CIRC. ELETTR.
CONTROLLO FILAMENTI
EFFIC. VALV.
ISOL. CAT.
EFF. D.RIV.
SPENTO
SELETTORE

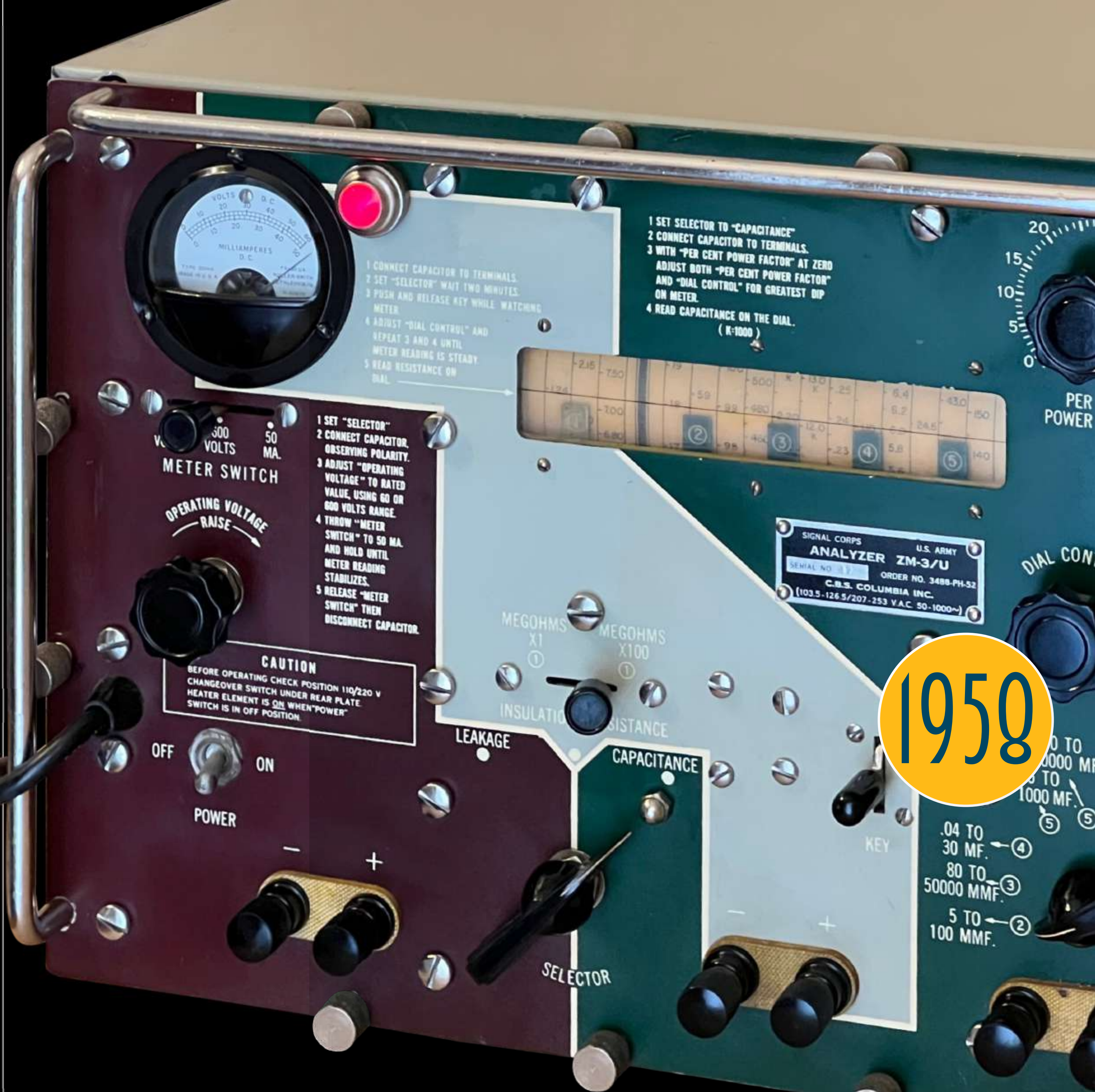
How good is this capacitor?

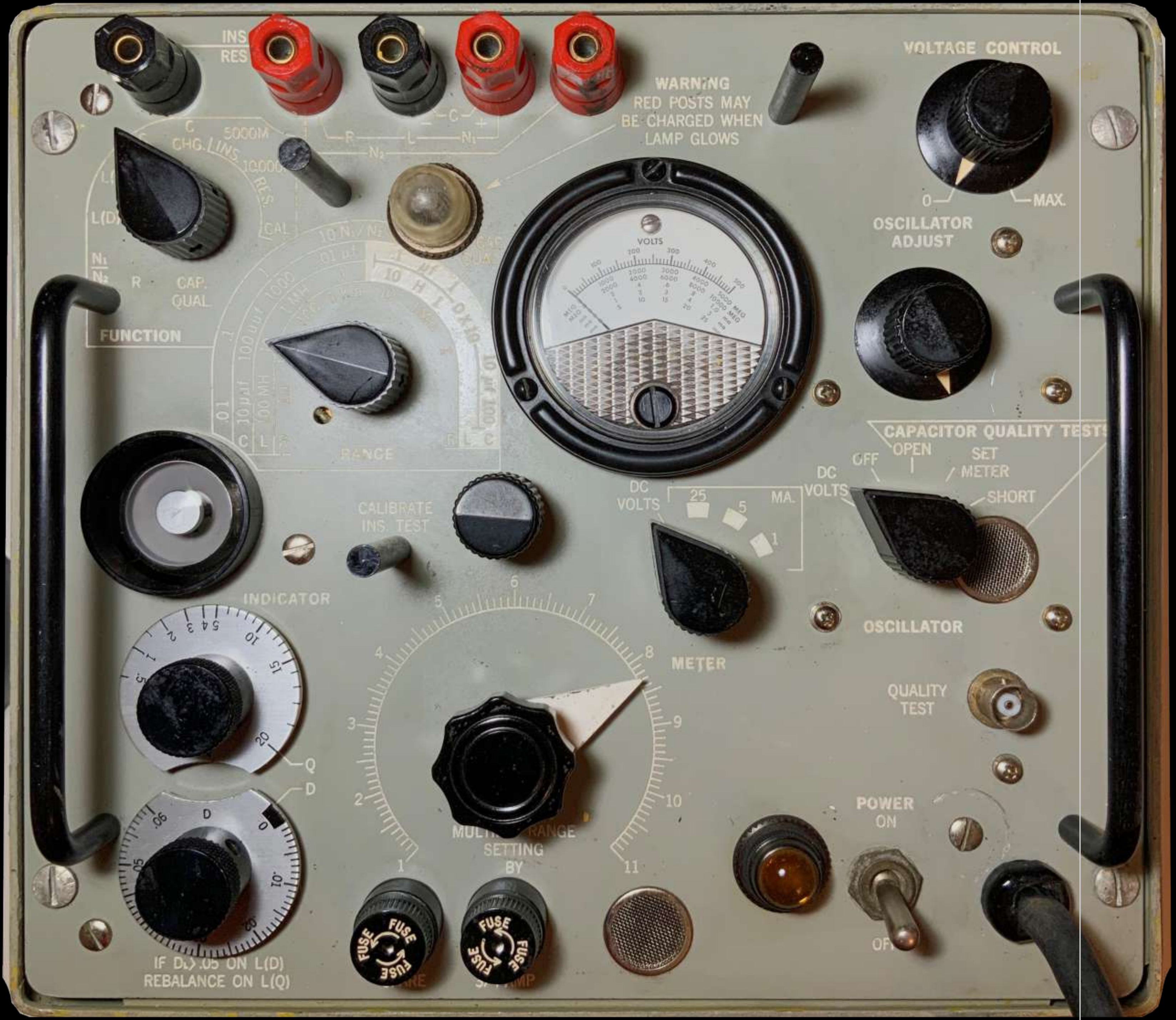
Another of the biggest problems restoring the old stuff, is that, in 50, 60, 70 years and more, some of the components, like resistor and capacitors, have changed their value. The capacitors, furthermore, tend to get leakages, i.e. they are no longer a block to direct current but act also as resistors. In some cases, especially the electrolytic capacitors, they start dissipating energy, in that resistor, and can even explode. Checking the resistors with a normal multimeter is easy, but what about the capacitors?

You need a special instrument to do that. In this pages, the ZM-3/U analyser. It can measure the value of the capacitors, test them with voltages up to 600 V and measure their leakage, if any. Something like that is absolutely necessary if you want to restore a "boatanchor".

In the photos: the ZM-3/U analyzer has a wonderful mechanics, 9 tubes and can operate at 115 or 220V. This unit is from 1959 and almost as new, thanks to the original metal protective box (see picture).


R-30
R17
FUSE
ANALYZER
ZM-3/U


1958
MILLIAMPERES D.C.
VOLTS D.C.
1 CONNECT CAPACITOR TO TERMINALS.
2 SET "SELECTOR" WAIT TWO MINUTES.
3 PUSH AND RELEASE KEY WHILE WATCHING METER.
4 ADJUST "DIAL CONTROL" AND REPEAT 3 AND 4 UNTIL METER READING IS STEADY
5 READ RESISTANCE ON DIAL.
1 SET SELECTOR TO "CAPACITANCE"
2 CONNECT CAPACITOR TO TERMINALS.
3 WITH "PER CENT POWER FACTOR" AT ZERO ADJUST BOTH "PER CENT POWER FACTOR" AND "DIAL CONTROL" FOR GREATEST DIP ON METER.
4 READ CAPACITANCE ON THE DIAL.
(K=1000)
600 VOLTS
50 MA.
METER SWITCH
1 SET "SELECTOR"
2 CONNECT CAPACITOR, OBSERVING POLARITY.
3 ADJUST "OPERATING VOLTAGE" TO RATED VALUE, USING 60 OR 600 VOLTS RANGE.
4 THROW "METER SWITCH" TO 50 MA. AND HOLD UNTIL METER READING STABILIZES.
5 RELEASE "METER SWITCH" THEN DISCONNECT CAPACITOR.
OPERATING VOLTAGE
RAISE
CAUTION
BEFORE OPERATING CHECK POSITION 110/220 V CHANGEOVER SWITCH UNDER REAR PLATE. HEATER ELEMENT IS ON WHEN "POWER" SWITCH IS IN OFF POSITION.
OFF
ON
POWER
SIGNAL CORPS
U.S. ARMY
ANALYZER ZM-3/U
SERIAL NO.
ORDER NO. 3488-PH-52
C.B.S. COLUMBIA INC.
(103.5-126.5/207-253 V.A.C. 50-1000~)
MEGOHMS X1
MEGOHMS X100
INSULATION
RESISTANCE
LEAKAGE
CAPACITANCE
SELECTOR
KEY
PER CENT POWER FACTOR
DIAL CONTROL
.04 TO 30 MF.
80 TO 50000 MMF.
5 TO 100 MMF.
1000 MF.
–
+


WARNING
RED POSTS MAY
BE CHARGED WHEN
LAMP GLOWS
VOLTAGE CONTROL
0
MAX.
OSCILLATOR
ADJUST
FUNCTION
CAP.
QUAL
RANGE
VOLTS
CAPACITOR QUALITY TEST
OPEN
SET
METER
SHORT
OFF
DC
VOLTS
MA.
CALIBRATE
INS. TEST
INDICATOR
OSCILLATOR
METER
QUALITY
TEST
POWER
ON
OFF
MULTIPLY RANGE
SETTING
BY
FUSE
IF D>.05 ON L(D)
REBALANCE ON L(Q)

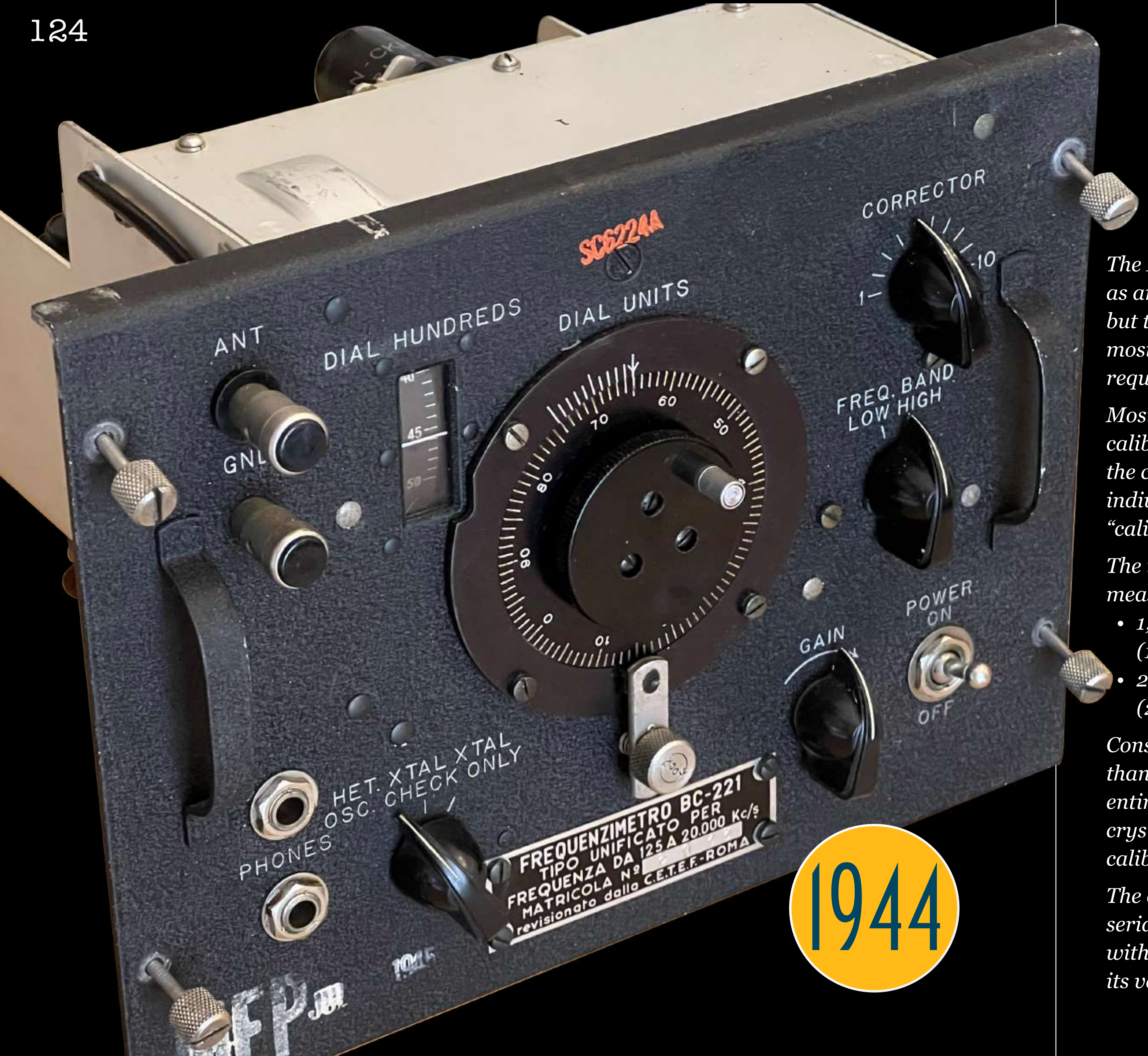
1959

ZM-11/U bridge

ZM-11/U (left) is perhaps the portable son of ZM-3/U, seen before. It can measure capacitance, inductance, resistance, iron-cored transformer turns ratio, dissipation factor of inductors at 1,000 Hz, and insulation resistance of capacitors and other electronic parts, as well as leakage of electrolytic capacitors at direct current. The general condition of many capacitors may be determined without removal from their circuit using a test frequency of about 10.75 MHz.

As said, leaking capacitors are a typical problem in very old electronic equipment, so I find ZM-11/U very useful to test the capacitor leakage at their nominal voltage rating, operation impossible with a normal modern multimeter.

Although it is designed primarily for maintenance use, its overall accuracy is rather good and about one-half that usually realised by laboratory instruments of that time.


SC6224A
ANT
GND
DIAL HUNDREDS
DIAL UNITS
CORRECTOR
1
10
FREQ. BAND
LOW HIGH
POWER
ON
OFF
GAIN
HET. XTAL OSC.
XTAL CHECK ONLY
PHONES
FREQUENZIMETRO BC-221
TIPO UNIFICATO PER
FREQUENZA DA 125 A 20.000 Kc/s
MATRICOLA Nº
revisionato dalla C.E.T.E.F.-ROMA

1944

BC-221 frequency meter

*The **BC-221** is very peculiar instrument. Defined as a heterodyne frequency meter, can be used also as an emergency signal generator. In the last edition of this document, I dedicated little space to it, but the BC-221 deserves more. Thanks to its a superb mechanics, like the Jeep, it was used in the most different applications, where a stable and precise frequency source or measurement was required.*

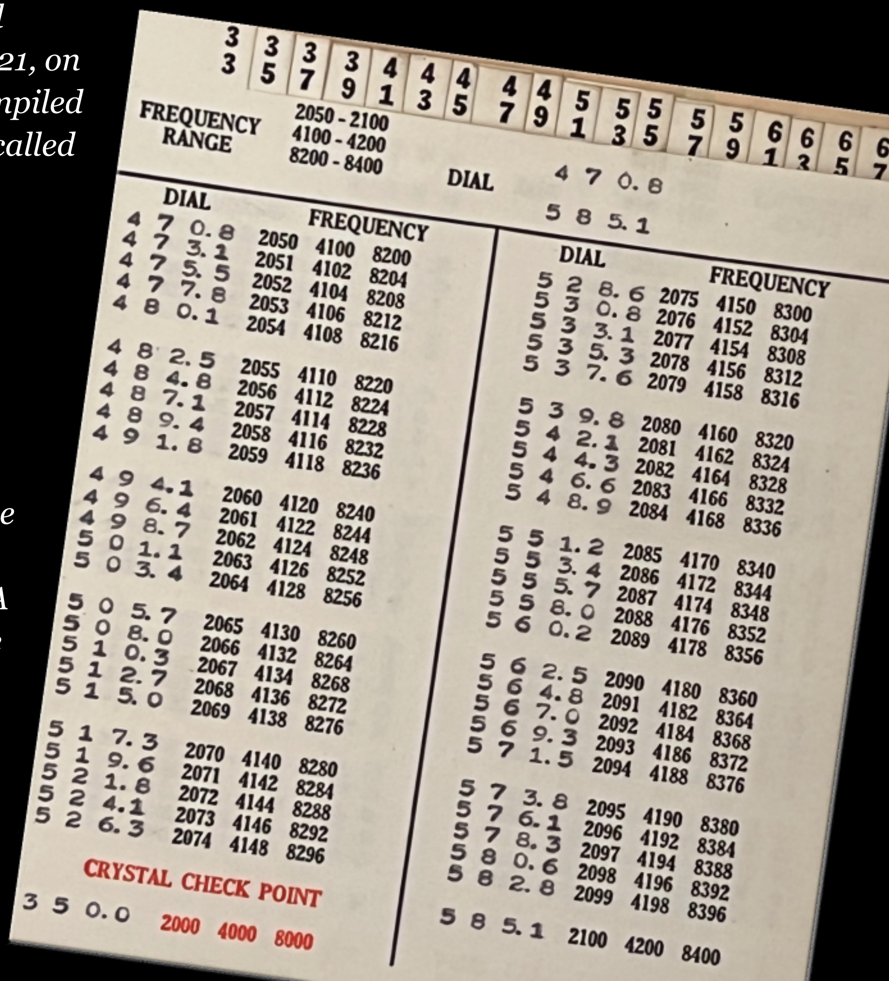
Most signal generators rely only on the dial calibration to ensure precision. Every BC-221, on the contrary, comes with a set of tables, compiled individually for that specific unit, together called "calibration book".

The tables contain altogether 3,252 measurements points:

- *1,251 100Hz-spaced in the low band (125-250kHz);*
- *2,001 1kHz-spaced in the high band (2,000-4,000kHz).*

Considering the armonics, there are so more than 15,000 measurement point over the entire frequency range (125kHz÷20MHz). A crystal allows the values on each page to be calibrated.

The calibration book must have the same serial number of the BC-221. A unit without the calibration book loses most of its value.


33
35
37
39
41
43
45
47
49
51
53
55
57
59
61
63
65
67

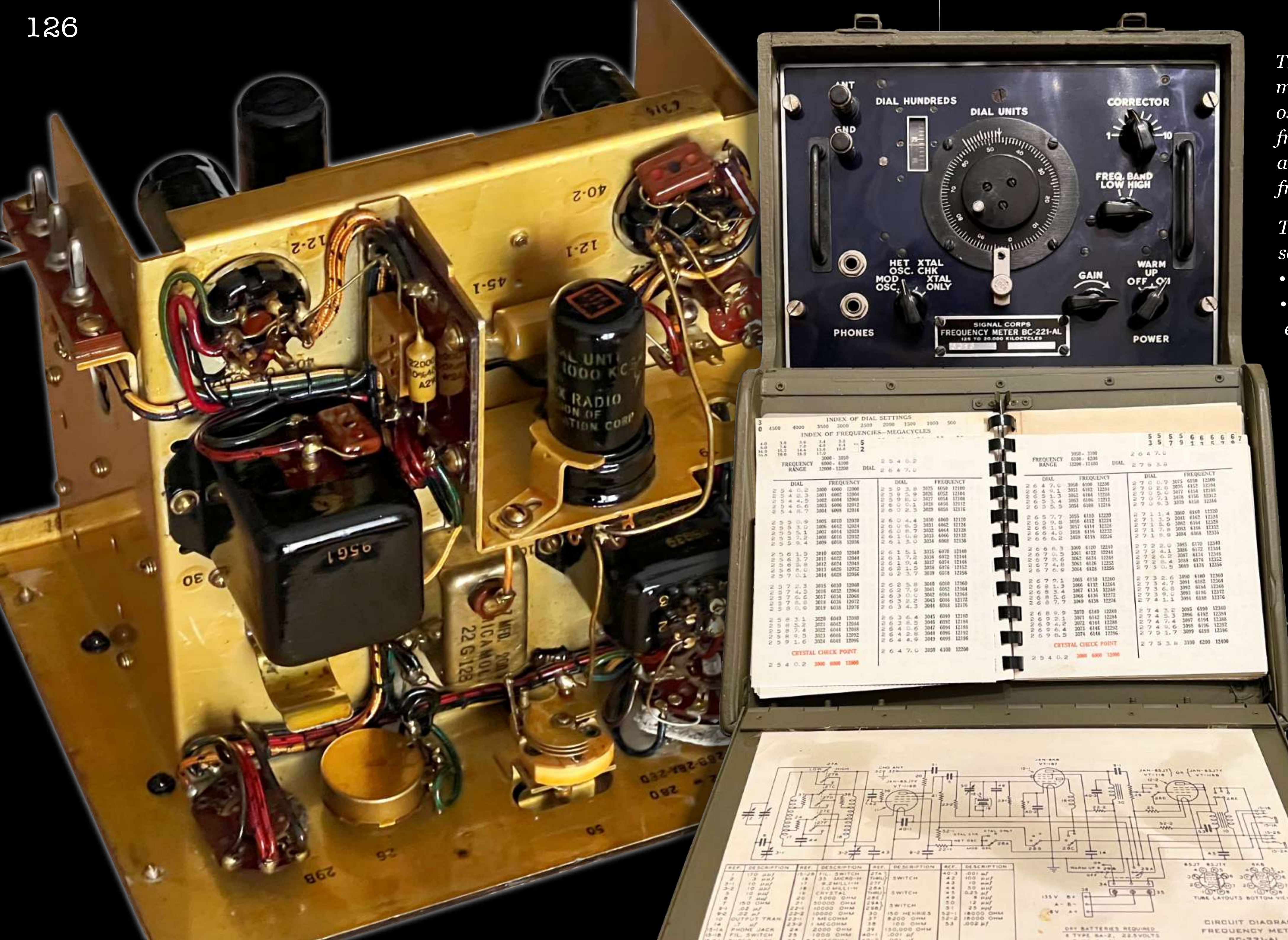
FREQUENCY RANGE
2050 - 2100
4100 - 4200
8200 - 8400

DIAL
470.8
585.1

DIAL	FREQUENCY		
470.8	2050	4100	8200
473.1	2051	4102	8204
475.5	2052	4104	8208
477.8	2053	4106	8212
480.1	2054	4108	8216
482.5	2055	4110	8220
484.8	2056	4112	8224
487.1	2057	4114	8228
489.4	2058	4116	8232
491.8	2059	4118	8236
494.1	2060	4120	8240
496.4	2061	4122	8244
498.7	2062	4124	8248
501.1	2063	4126	8252
503.4	2064	4128	8256
505.7	2065	4130	8260
508.0	2066	4132	8264
510.3	2067	4134	8268
512.7	2068	4136	8272
515.0	2069	4138	8276
517.3	2070	4140	8280
519.6	2071	4142	8284
521.8	2072	4144	8288
524.1	2073	4146	8292
526.3	2074	4148	8296
528.6	2075	4150	8300
530.8	2076	4152	8304
533.1	2077	4154	8308
535.3	2078	4156	8312
537.6	2079	4158	8316
539.8	2080	4160	8320
542.1	2081	4162	8324
544.3	2082	4164	8328
546.6	2083	4166	8332
548.9	2084	4168	8336
551.2	2085	4170	8340
553.4	2086	4172	8344
555.7	2087	4174	8348
558.0	2088	4176	8352
560.2	2089	4178	8356
562.5	2090	4180	8360
564.8	2091	4182	8364
567.0	2092	4184	8368
569.3	2093	4186	8372
571.5	2094	4188	8376
573.8	2095	4190	8380
576.1	2096	4192	8384
578.3	2097	4194	8388
580.6	2098	4196	8392
582.8	2099	4198	8396
585.1	2100	4200	8400

CRYSTAL CHECK POINT

350.0 2000 4000 8000


ANT
GND
DIAL HUNDREDS
DIAL UNITS
CORRECTOR
FREQ. BAND LOW HIGH
HET OSC.
XTAL CHK
MOD OSC.
XTAL ONLY
GAIN
WARM UP
OFF ON
PHONES
POWER
SIGNAL CORPS
FREQUENCY METER BC-221-AL
125 TO 20,000 KILOCYCLES
INDEX OF DIAL SETTINGS
INDEX OF FREQUENCIES—MEGACYCLES
CRYSTAL CHECK POINT
CIRCUIT DIAGRAM
FREQUENCY METER

The BC-221 can perform measurements, not easy even with modern instruments. E.g. you can measure the frequency of an oscillator without disturbing it with the probe of the digital frequency meter or the oscilloscope. Just turn a couple of turns of a wire around the valve and you can determine its oscillating frequency.

There are many BC-221 variants, but the major differences aren't so big and can be resumed in two points:

- *having the 400Hz amplitude modulation possibility or less:*
- *having the box in metal or wood. The latter is often better evaluated, because the wood offer a better thermal stability.*

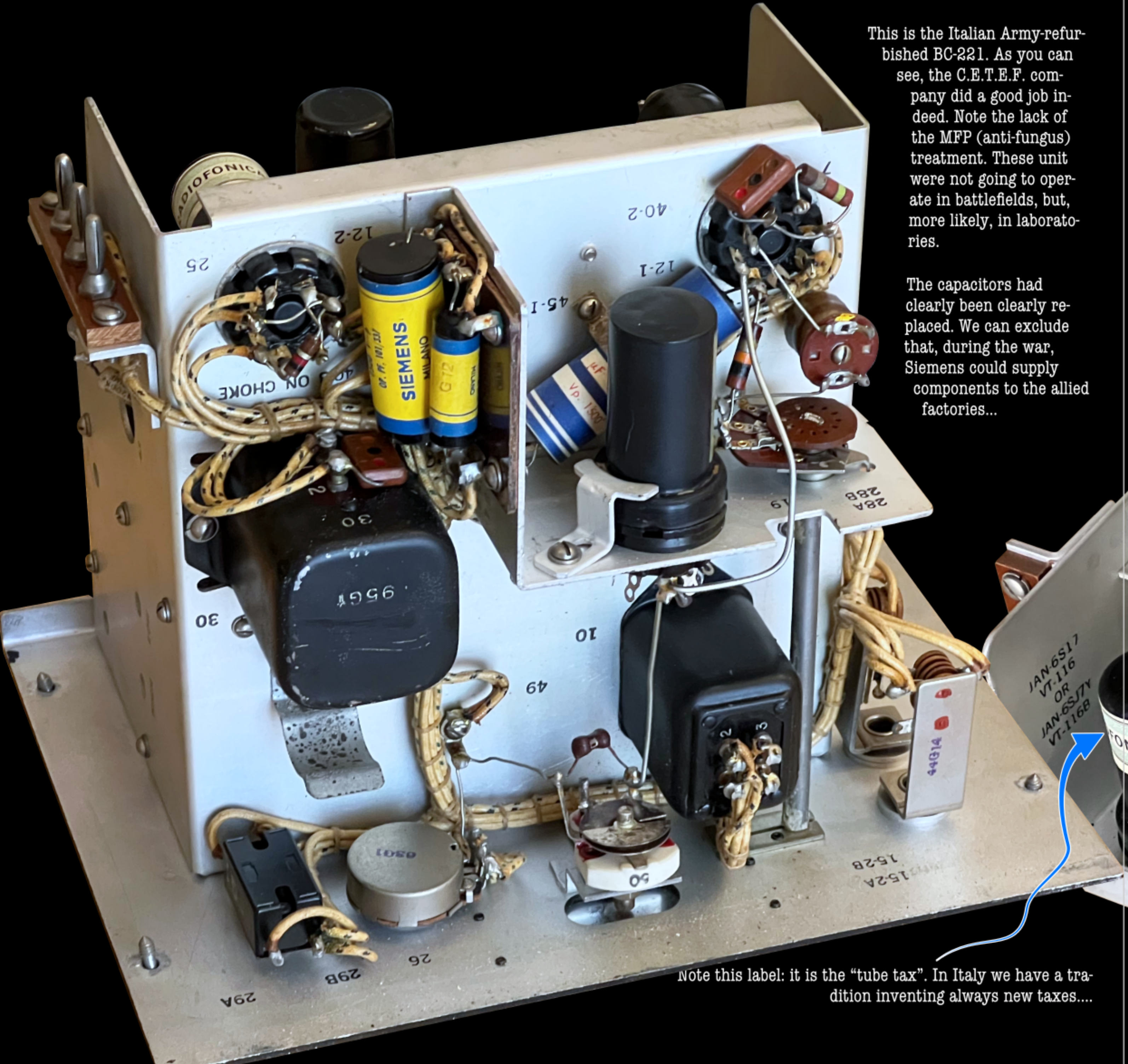
I own two samples of BC-221, both in wooden box, that you can see here depicted. The first, shown in this pages, is an AL-type, with AF modulation. The yellowish tint in the internals is due to the fungus-proof treatment.

The second is in some way special. After the WW2, the not-rich Italian army decided to recondition the old American BC-221s instead of buying new equipment. My second BC-221 was one of them and was refurbished by a certain C.E.T.E.F. firm from Rome, who did a really good job, but changed the labels, so I am not sure about the exact model type.

Both are still rather well calibrated. The difference between the two calibration xtals is limited to about 30Hz.

Hidden treasures: here on the right, the spare tubes hidden in the upper zone of the case.

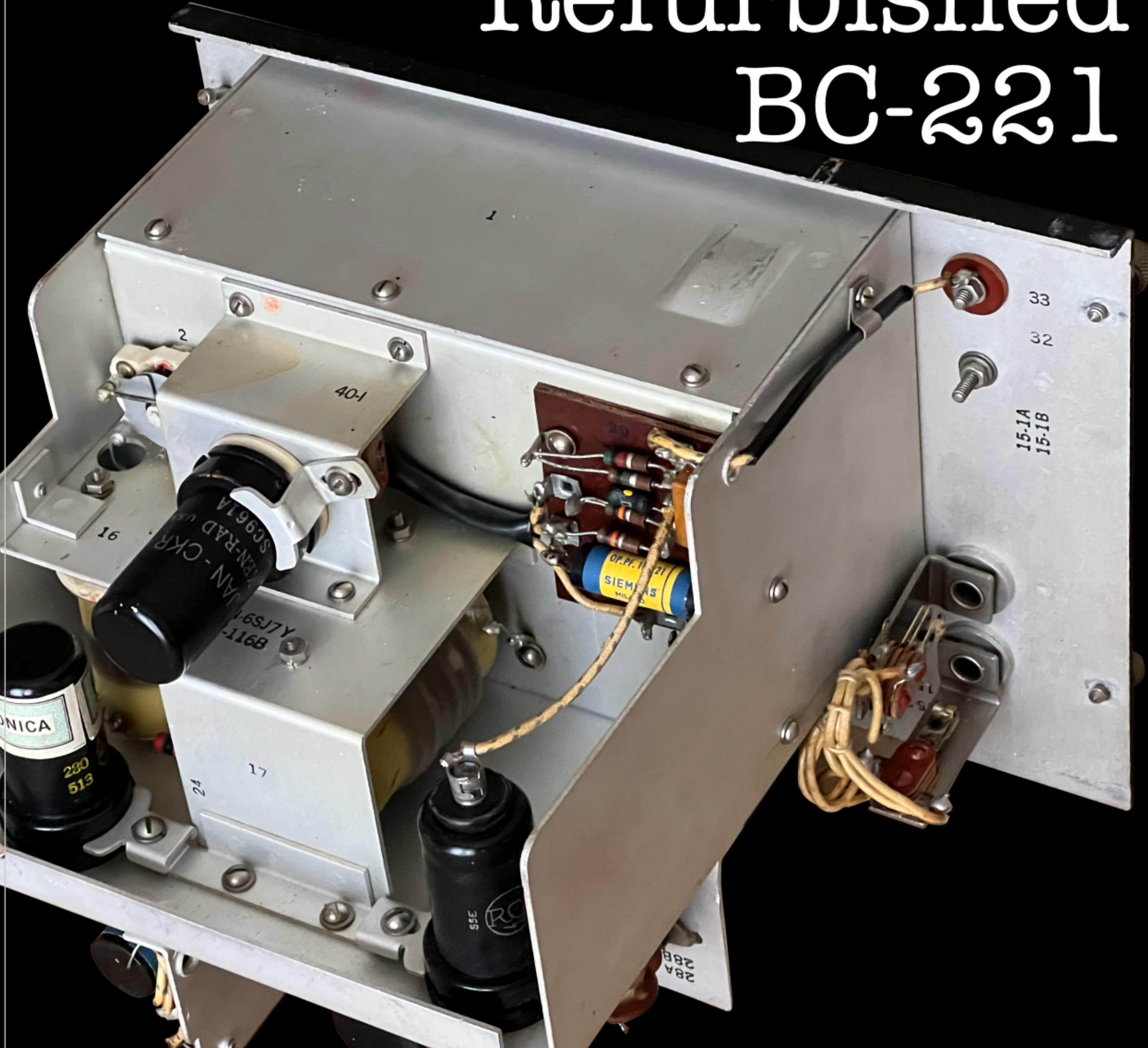
Refurbished BC-221



This is the Italian Army-refurbished BC-221. As you can see, the C.E.T.E.F. company did a good job indeed. Note the lack of the MFP (anti-fungus) treatment. These unit were not going to operate in battlefields, but, more likely, in laboratories.

The capacitors had clearly been clearly replaced. We can exclude that, during the war, Siemens could supply components to the allied factories...

Note this label: it is the "tube tax". In Italy we have a tradition inventing always new taxes....



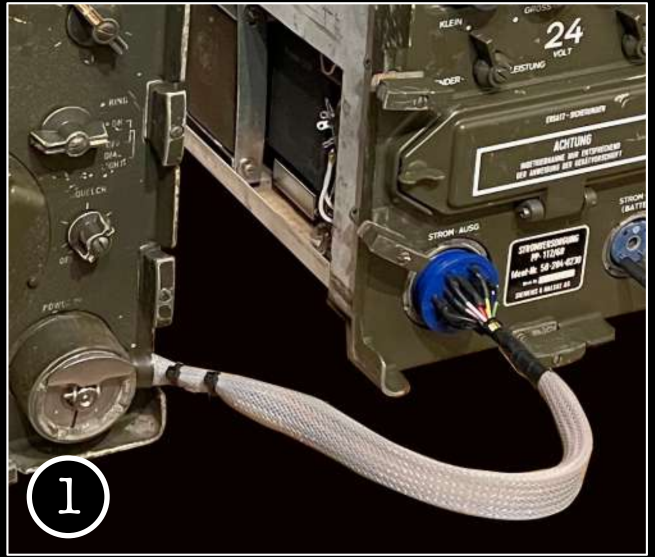
TS-505/U voltmeter

A Vacuum-Tube Volt Meter is a voltmeter capable of measuring a voltage without disturbing too much the circuit under measure, where impedances are high, as normally it happens with vacuum tubes. In general, today electronic multimeter have high input impedance and make non-necessary the use of a VTVM. But TS-505/U, in my opinion, is a special case, because many manuals of receivers and transmitters refer to it, so, with it, I am more confident that the value I read is the correct one.

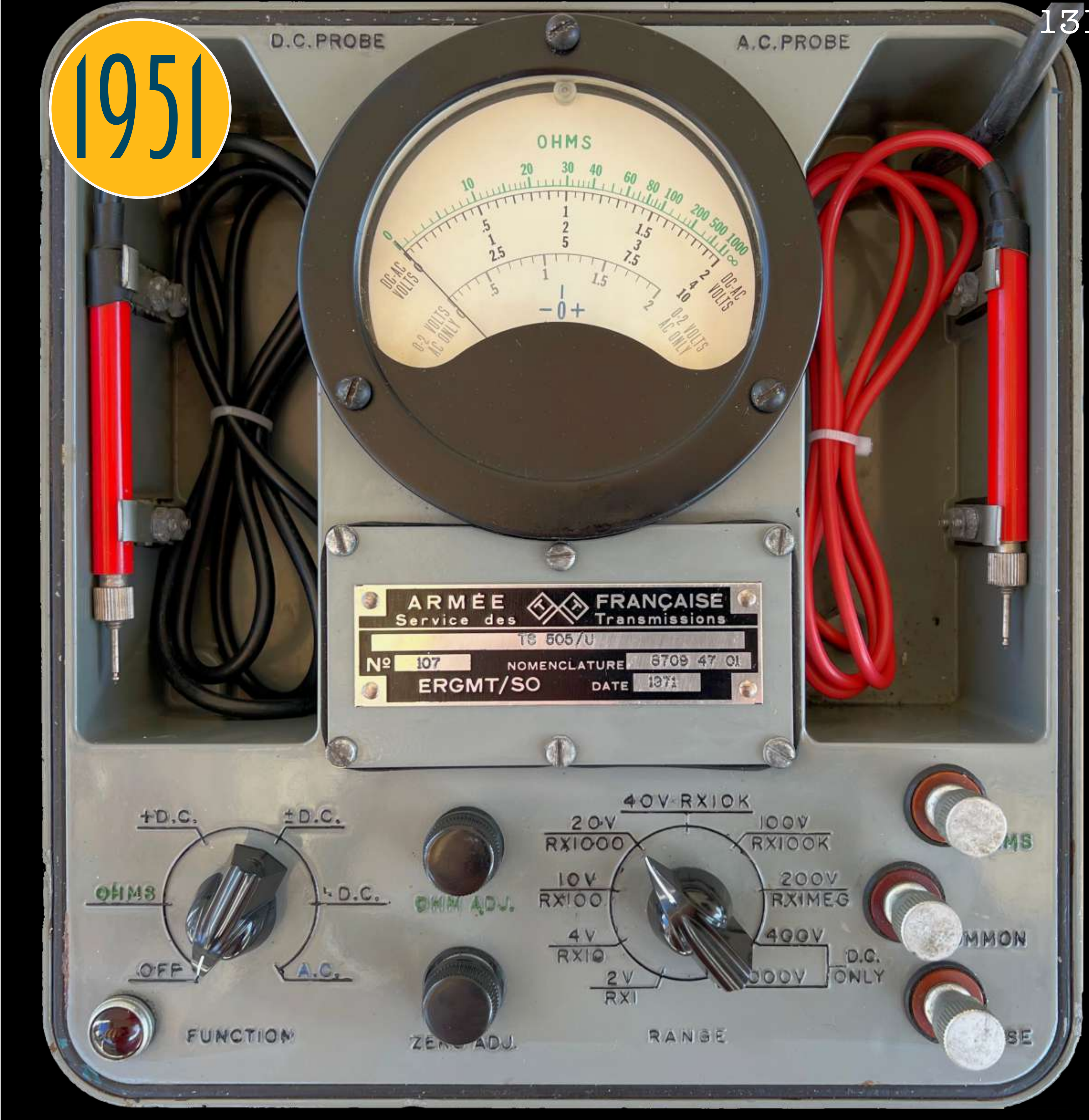
***TS-505 /U** is a general purpose AC and DC VTVM and a DC ohmmeter. Completely watertight, permits the measurement of voltage and resistance over relatively wide ranges. There arc nine DC voltage ranges which permit measurement from 0,05 to 1,000 volts. The input resistance is 20 M ohm (50 M on 1,000 V range), i.e. more than twice than a modern multimeter. There are seven AC voltage ranges which permit measurement from 0.05 to 200 volts. The input capacity is 2 pF, shunted by a resistance greater than 6 megohms over the audio range. The AC voltage measurement is accurate from 30 Hz to 500 MHz. There are seven resistance ranges with midscale readings of 30 ohms and multiples thereof. The highest resistance range can be used to measure insulation resistance. The zero centre DC scale permits the measurement of DC voltage of unknown polarity.*

❶ Extension cables are often required to test modules out of the equipment. It is no easy to find the originals; normally, if you want them, you need to build them by yourself.

❷ Other tools from the remote era: precious tube pullers and a socket extender to perform measurements without having to go on the bottom side of the chassis.


①

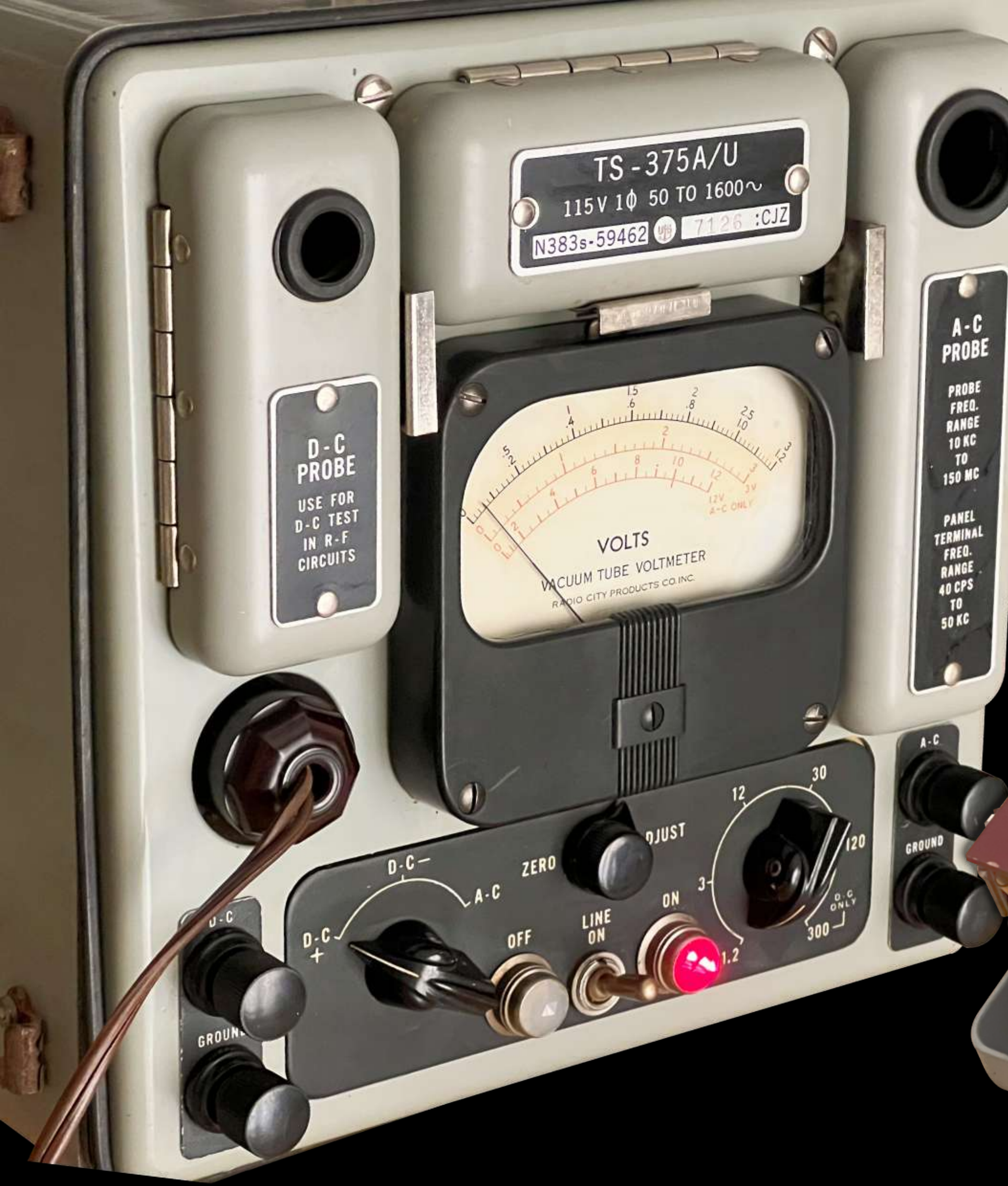
②

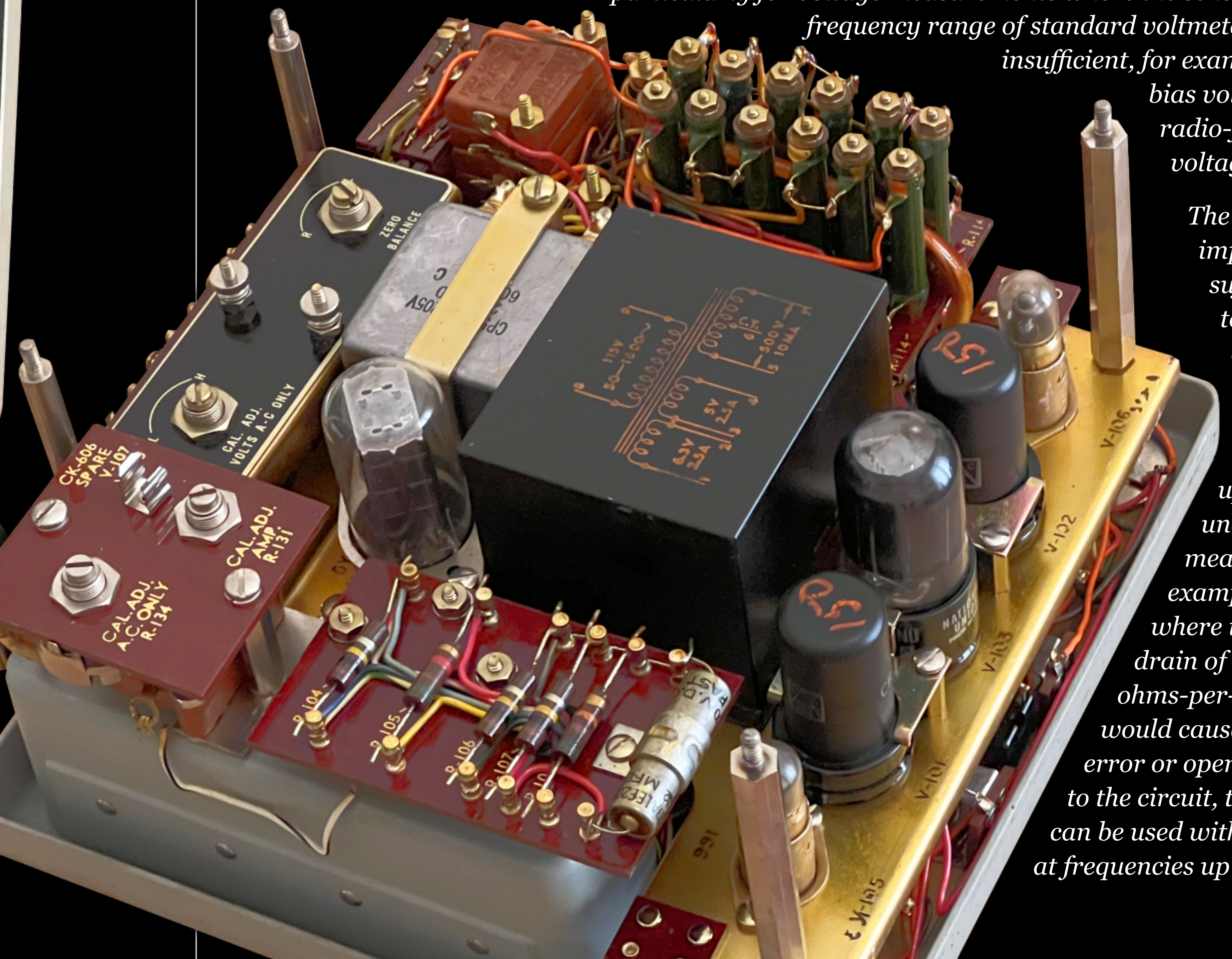

1951
D.C. PROBE
A.C. PROBE
OHMS
DC-AC VOLTS
0-2 VOLTS AC ONLY
ARMÉE FRANÇAISE
Service des Transmissions
TS 505/U
Nº 107
NOMENCLATURE 6709 47 01
ERGMT/SO
DATE
+D.C.
±D.C.
OHMS
-D.C.
OFF
A.C.
FUNCTION
OHM ADJ.
ZERO ADJ.
40V RX10K
20V RX1000
100V RX100K
10V RX100
200V RX1MEG
4V RX10
400V
2V RX1
1000V
D.C. ONLY
RANGE

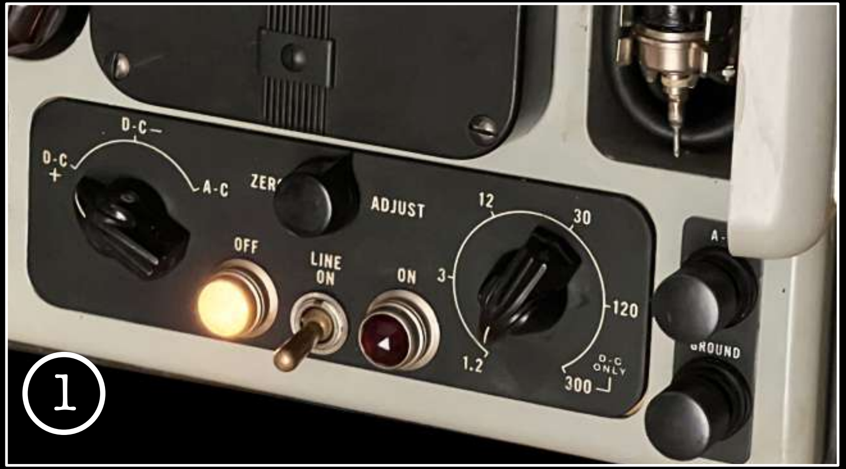
TS-375/U

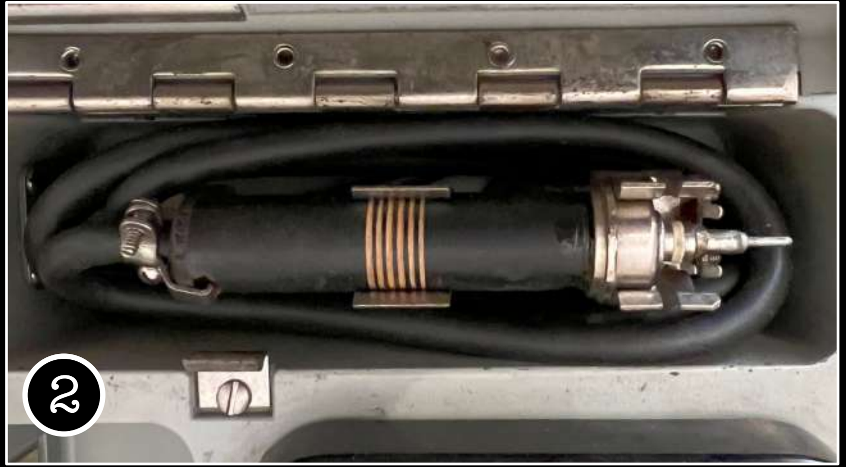
I had been wishing to get hold of a TS-375/U voltmeter because many radio equipment manuals refer to it for the calibration process. This device is actually a general-purpose high-impedance AC and DC voltmeter designed for servicing and testing radio and radar equipment. It is intended particularly for voltage measurements where the sensitivity or frequency range of standard voltmeters is insufficient, for example d-c grid bias voltage, audio or radio-frequency voltage.

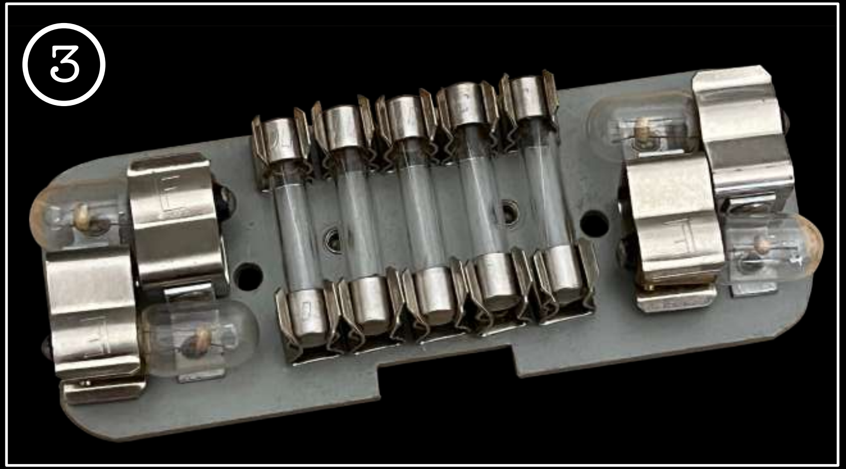
The input impedance is sufficiently high to avoid consideration of the instrument current drain upon the circuit undergoing measurement. For example in circuits where the current drain of a 20,000 ohms-per-volt voltmeter would cause a serious error or operational upset to the circuit, this instrument can be used without difficulty, at frequencies up to 300MHz.


TS-375A/U
115V 1ϕ 50 TO 1600~
N383s-59462
7126 :CJZ
D-C PROBE
USE FOR D-C TEST IN R-F CIRCUITS
A-C PROBE
PROBE FREQ. RANGE 10 KC TO 150 MC
PANEL TERMINAL FREQ. RANGE 40 CPS TO 50 KC
VOLTS
VACUUM TUBE VOLTMETER
RADIO CITY PRODUCTS CO.INC.
ZERO ADJUST
D-C
A-C
OFF
LINE ON
ON
GROUND


ZERO BALANCE
CAL. ADJ. VOLTS A-C ONLY
CK-606 SPARE V-107
CAL. ADJ. AMP R-131
CAL. ADJ. A-C ONLY R-134
V-106
V-102
V-103
V-101
V-105


①
D-C
D-C +
A-C
ZERO
ADJUST
OFF
LINE ON
ON
12
30
3
120
1.2
300
D-C ONLY
GROUND





TS-375/U characteristics

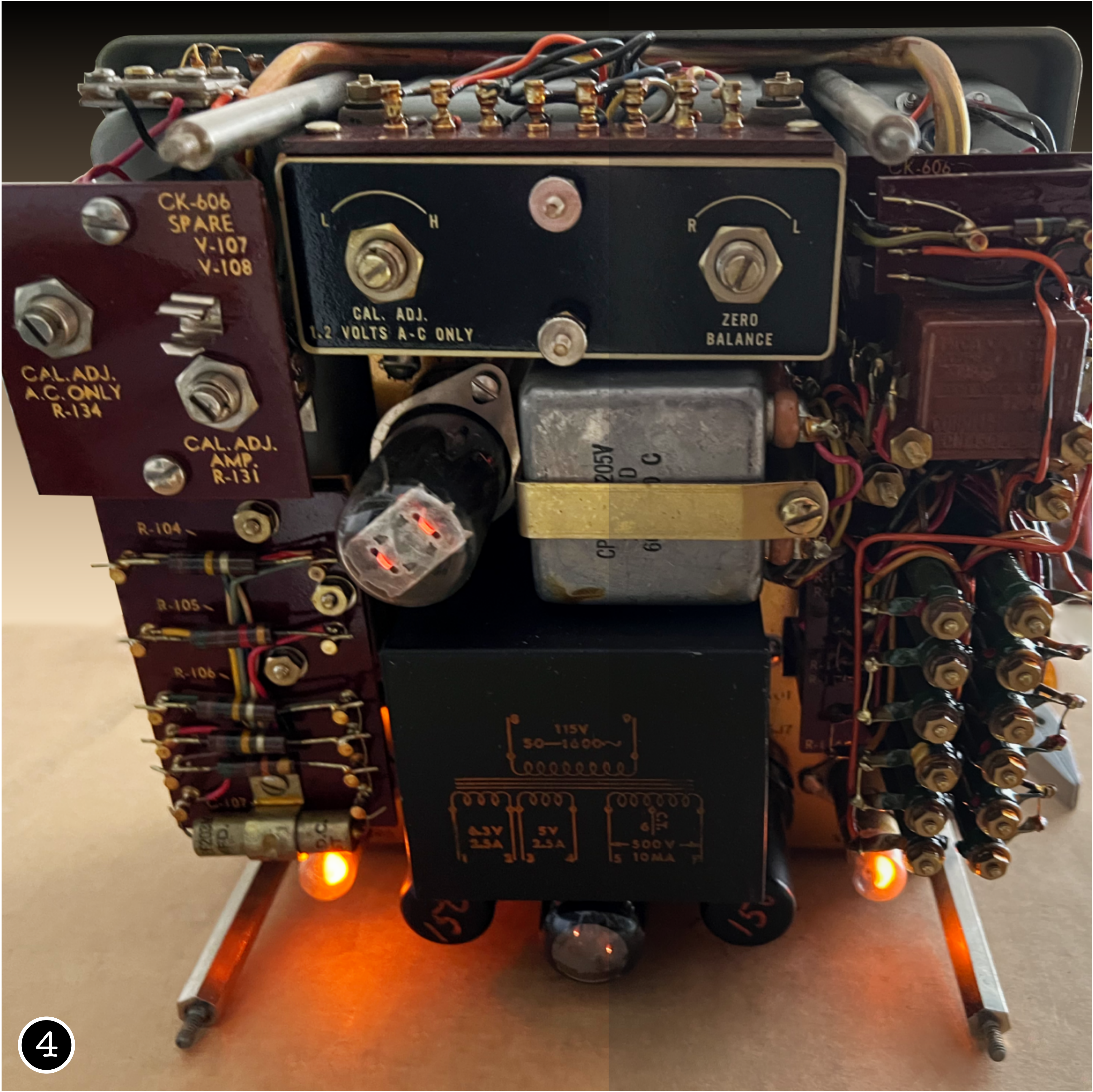
- *DC positive or negative polarity: 1.2, 3, 12, 30, 300 volts, with a constant input resistance of 30 MOhm;*
- *AC ranges: 1.2, 3, 12, 30 and 120 volts with a 5 megohm resistance on all ranges. It can be used from 40HZ to 50kHz connecting directly to the panel terminals, and from 10kHz to 150MHz using the active probe, which presents an input capacity of approximately 5pF.*

❶ ON WHEN OFF. The TS-375/U has, as normal, an indicating lamp for the ON state, but strangely, has a lamp also to indicate the OFF state. That because a heater warms the unit when OFF, to have a better temperature stability.

❷ ACTIVE AC PROBE. It consists of a CK-606-BX tube mini rectifier diode, a 5Mohm isolating resistor and a 500pF blocking capacitor, cased in a cylindrical bakelite case similar in appearance to a standard test probe but larger in diameter. In addition to the conventional test probe tip prod the contact end carries a circumferential ring for making a short ground connection when measuring high-frequency AC voltages.

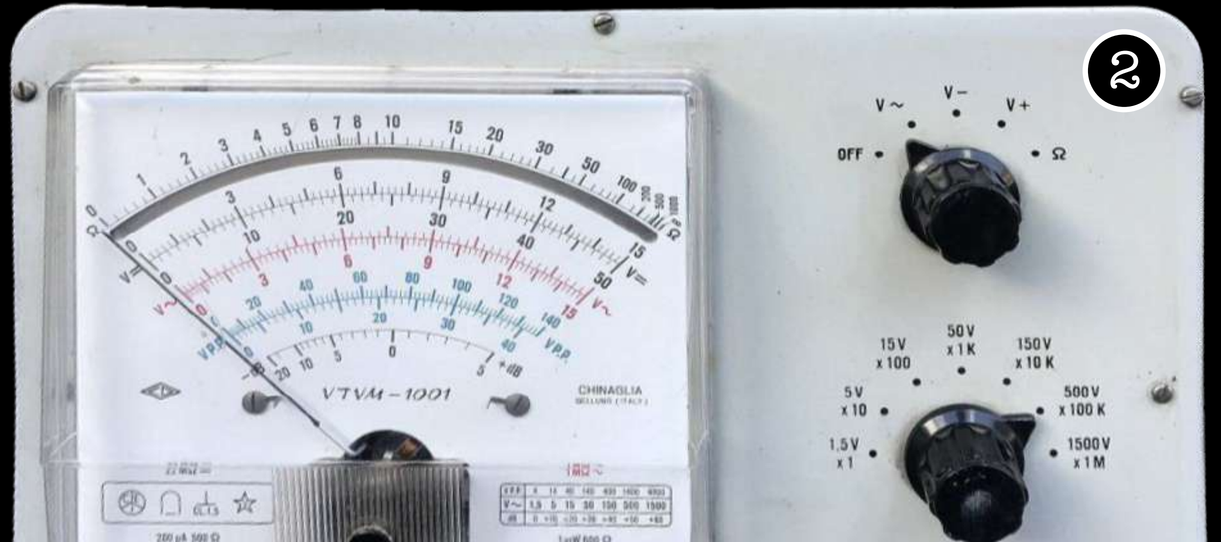
❸ SPARES. The front panel has three flaps, two for the DC and AC probes, another one for accessories, that embody the spares kit. A very careful design indeed.

❹ INTERNAL LAMPS. The two internal neon lamps are used as 62V voltage regulators. When they become old, they raise the discharge voltage and no longer light. Normally, it is not easy to find spares for them, but you can use normal Zener diodes of equivalent voltage (if you cannot find the exact value, you can connect more of them in series).

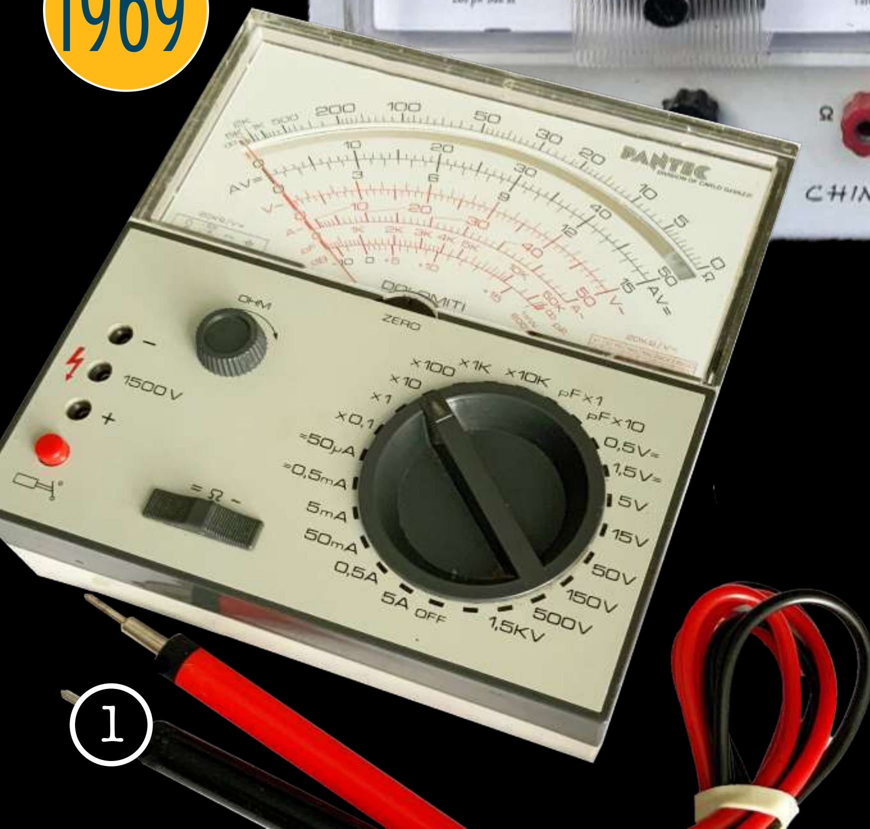

CK-606 SPARE V-107 V-108
CAL.ADJ. A.C.ONLY R-134
CAL.ADJ. AMP. R-131
L H
CAL. ADJ. 1.2 VOLTS A-C ONLY
R L
ZERO BALANCE
R-104
R-105
R-106
115V 50—1600~
6.3V 2.5A
5V 2.5A
500V 10MA
④

More voltmeters

1968


2
VTVM-1001
CHINAGLIA
OFF
V~
V−
V+
Ω
15V x100
50V x1K
150V x10K
5V x10
500V x100K
1,5V x1
1500V x1M
ZERO
OHM

1969


1
PANTEC
OHM
ZERO
1500V
50μA
0,5mA
5mA
50mA
0,5A
5A
OFF
1,5KV
500V
150V
50V
15V
5V
1,5V
0,5V
pFx10
pFx1
x10K
x1K
x100
x10
x1
x0,1

❶ Pantec Major analog multimeter. One of the latest before the arrive of the digital models, it was very performing, with a sensitivity of 40,000 ohm/V and 55 measure ranges.

❷ Chinaglia VTVM 1001 vacuum tube voltmeter, with 22 Mohm input DC resistance and 20 mV minimum reading. In AC it performed worse: 1 Mohm with 30 pF, with 100 kHz maximum. Note the mirror behind the hand of the instrument, to avoid the parallax error during the reading. It used only one tube and was a cheap instrument, but good enough for the radio/TV repairers of that time.

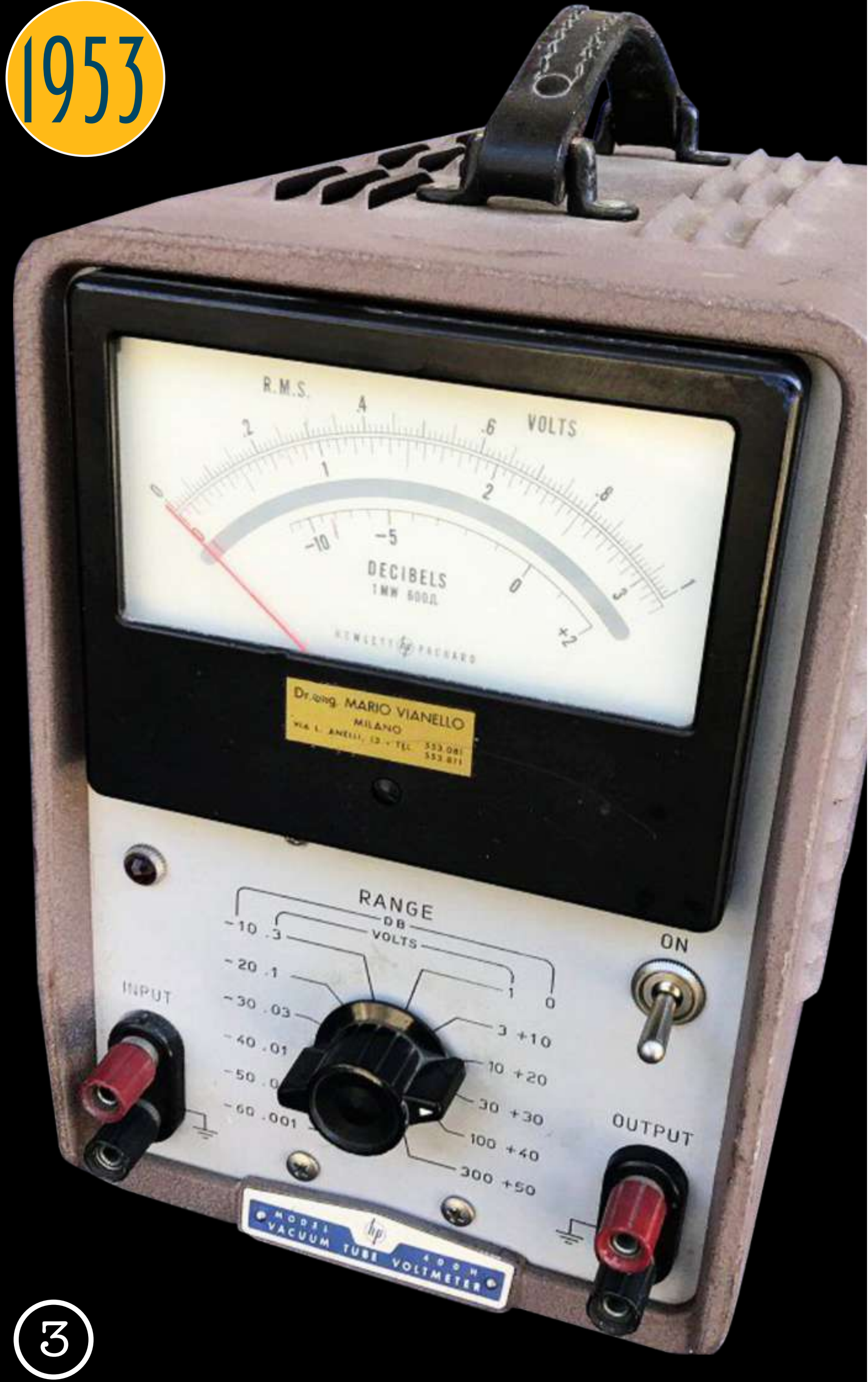
❸ Hewlett-Packard HP400H vacuum tube AC millivoltmeter and dB-meter. See a better description on next page.

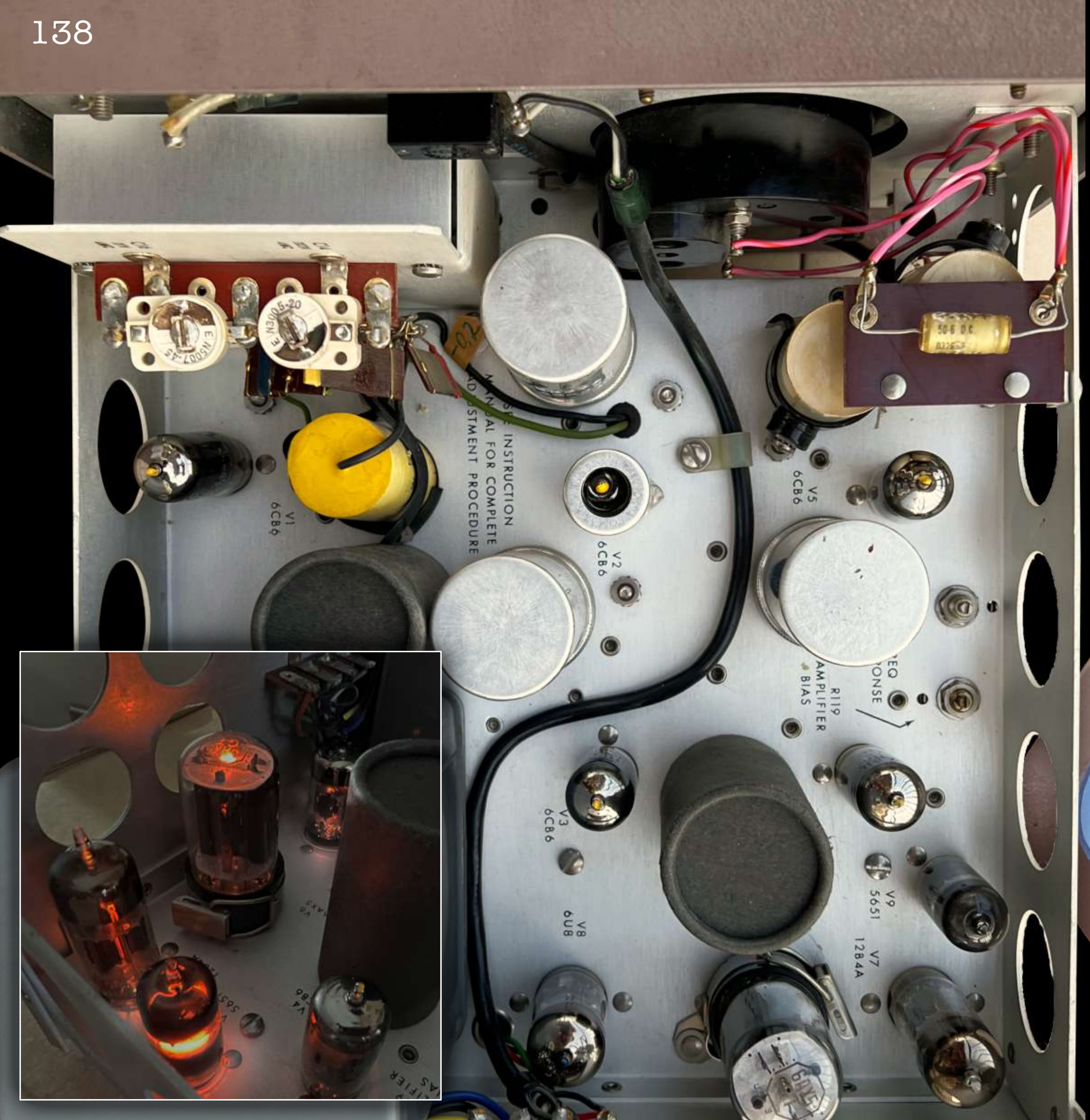
In the fifties, who could not afford a vacuum-tube voltmeter, had necessarily to make use of an analog multimeter, which, having no electronic amplifier, used the energy from the circuit under measure to move the hand of the instrument, altering the operation of the circuit itself.

Practically, it is like adding a resistance in parallel to the circuit. Its value is determined by an important parameter of the multimeter: "the ohms/volt", to be multiplied by the selected full scale value. For example, a 5,000 ohm/V multimeter, set to "10V", has a resistance of 10 x 5,000 = 50,000 ohm, a too low value for a tube circuit (a vacuum tube voltmeter has from 10 to 50 Mohm input resistance).

The hand of old analog instruments had, however, advantages respect to modern digital multimeters. For example, when aligning a receiver, it is much easier and faster to look at the hand for the peak, instead of having to mentally decode the fast upgrading numerical display, which is often rather confusing.

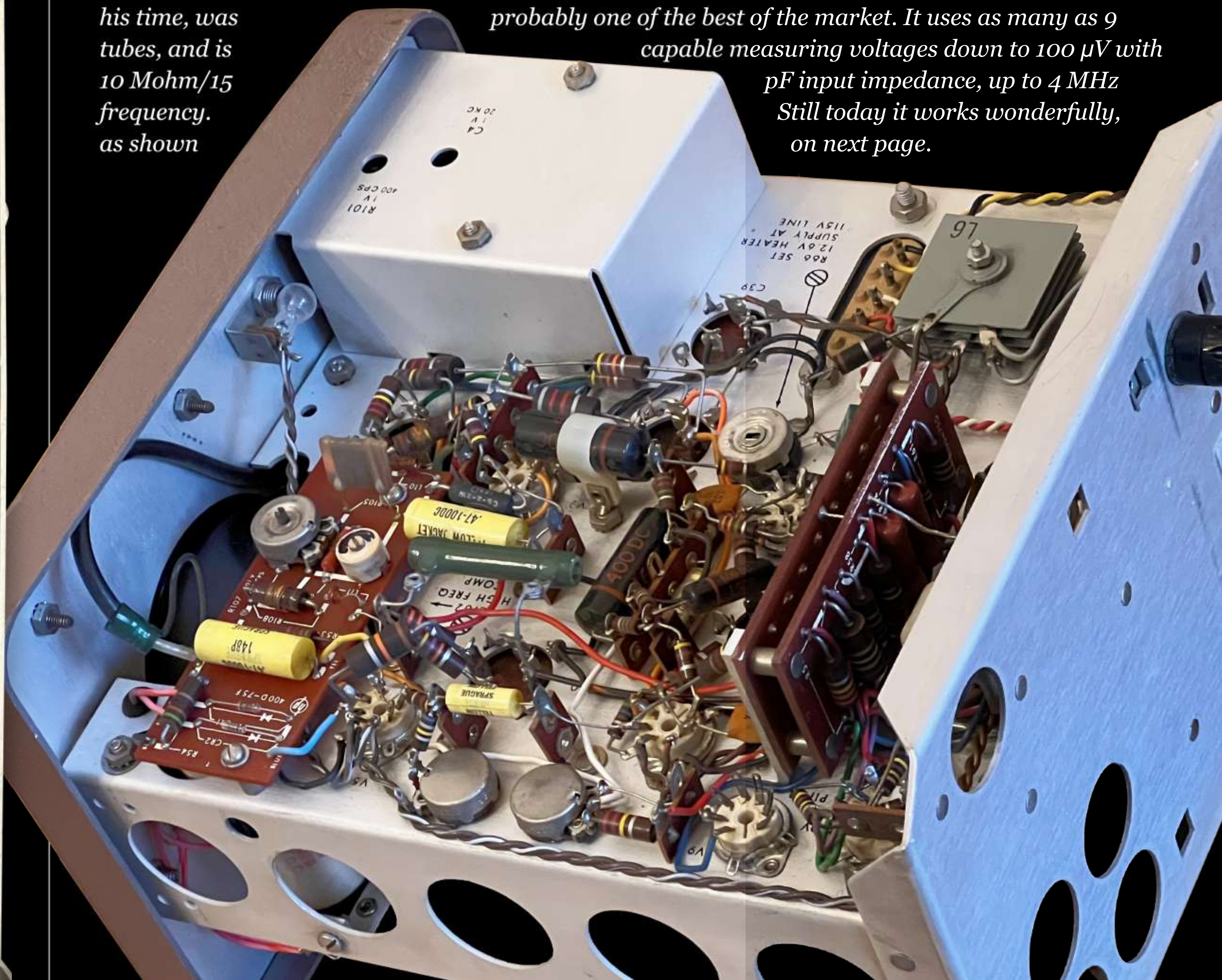
1953

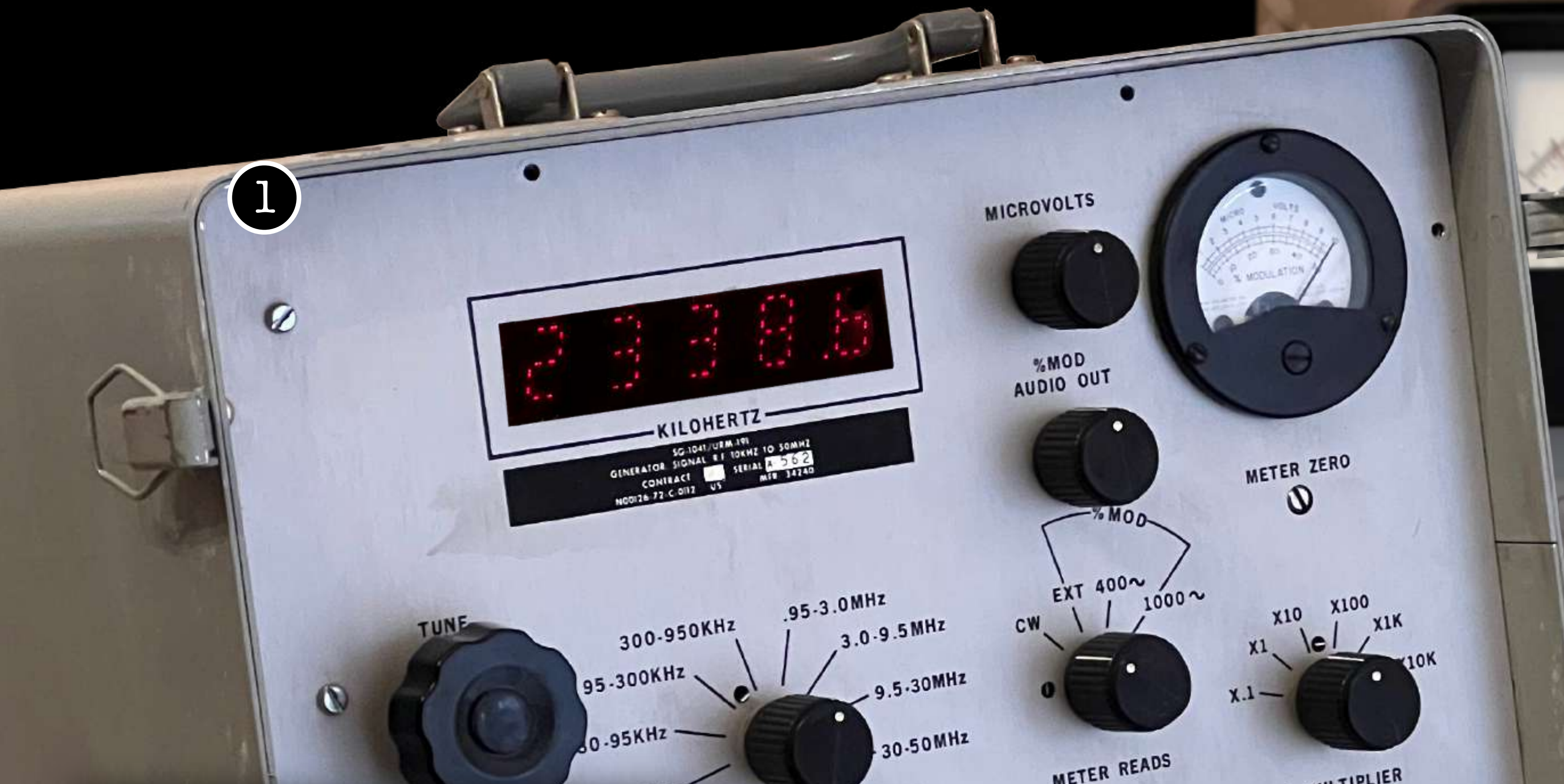

3
R.M.S.
VOLTS
DECIBELS
HEWLETT-PACKARD
Dr. ing. MARIO VIANELLO
MILANO
RANGE
DB
VOLTS
INPUT
ON
OUTPUT
MODEL 400H VACUUM TUBE VOLTMETER


V1 6CB6
V2 6CB6
V3 6CB6
V5 6CB6
V8 6U8
V9 5651
V7 12B4A
R119 AMPLIFIER BIAS
INSTRUCTION MANUAL FOR COMPLETE ADJUSTMENT PROCEDURE

HP400H voltmeter

The HP400H AC millivoltmeter (the H was the best version) was a valuable lab instrument, that, at his time, was probably one of the best of the market. It uses as many as 9 tubes, and is capable measuring voltages down to 100 μV with 10 Mohm/15 pF input impedance, up to 4 MHz frequency. Still today it works wonderfully, as shown on next page.




①
MICROVOLTS
2 3 3 8 6
KILOHERTZ
%MOD AUDIO OUT
METER ZERO
% MOD
EXT 400~
1000~
CW
TUNE
300-950KHz
.95-3.0MHz
3.0-9.5MHz
95-300KHz
9.5-30MHz
30-50MHz
X10
X100
X1
X1K
X10K
X.1
METER READS
RF MULTIPLIER
RF OUTPUT X200K OPEN CIRCUIT
EXT MOD IN AUDIO OUT
RF OUTPUT X MULTIPLIER

1970?

⑤
MARCONI INSTRUMENTS
10kHz-1·01GHz signal generator 2022E
CARRIER FREQUENCY
2.00000
MODULATION
RF LEVEL
SUPPLY ON
MOD IN OUT
RF OUTPUT 50Ω

URM-191

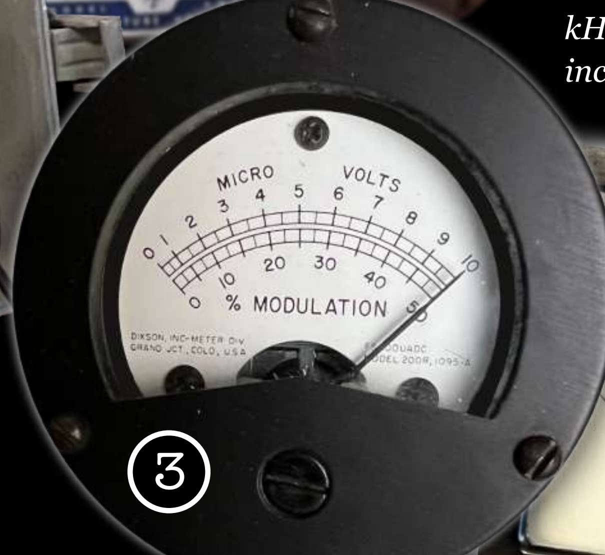
The AN/URM-191 (photo 1) is a more recent version of the better known AN/URM-25 signal generator. Its major innovation was the embedded digital frequency counter, something really disrupting with the old mechanical gears and scales.

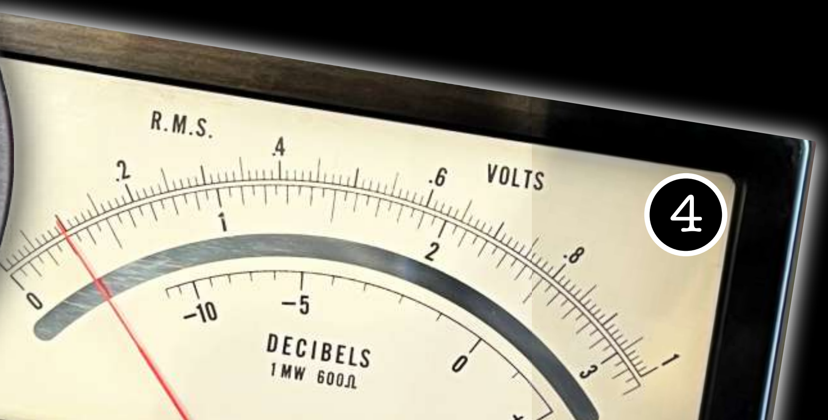
In this page, a real today test, in conjunction with the HP400H millivoltmeter (photo 2). As you can see on photo 3, the output was set to 2,238 MHz and 100 µV. The HP400H (photo 4) reads exactly 100 µV (honestly, I am not sure that this result can be achieved at all the frequencies and amplitudes). Note that the URM-191, as all the signal generators, must be terminated on a 50 ohm load, or you will get a voltage twice the expected.

The technology of the URM-190 was however not at top; probably, they were learning to use transistors, and also its internal construction is not lined up to other AN/... tube instruments. The stability is not rock-solid.

In the normal use, the Marconi 2022E synthesised 10 kHz - 1GHz generator (photo 5), much more modern, is incomparably superior, even if really complex to repair.

②
R.M.S.
VOLTS
DECIBELS
RANGE
ON
OUTPUT


③
MICRO
VOLTS
% MODULATION


④
R.M.S.
VOLTS
DECIBELS
1MW 600Ω

TS-497/URR signal generator

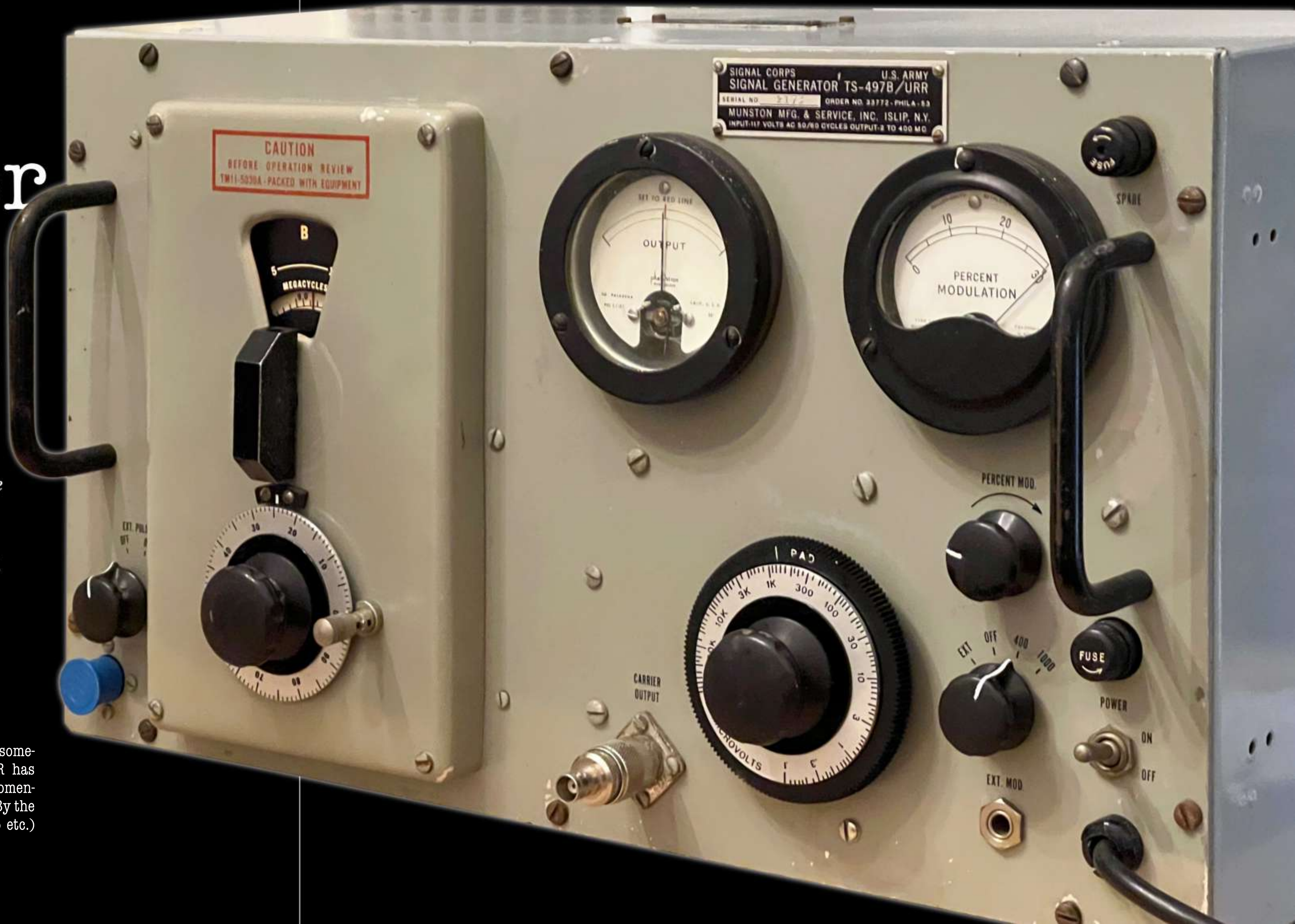
I bought this unit in an electronic fair for really few euros. It had not so much sex-appeal, so I neglected it for several months. When I decided to turn my attention to it, I realised that it is indeed a very interesting piece, embodying many innovative solutions, that I am going to introduce you.

Signal Generator TS-497B/URR was considered, at the time, a "portable unit" (near 30kg!) which provides RF test signals over a range of 2 to 400 MHz in six bands and was designed primarily for making "the precise measurements required in the maintenance of radio equipment".

TS-497/URR has an ugly and anonymous look, that soon changes when it shows its interiors.

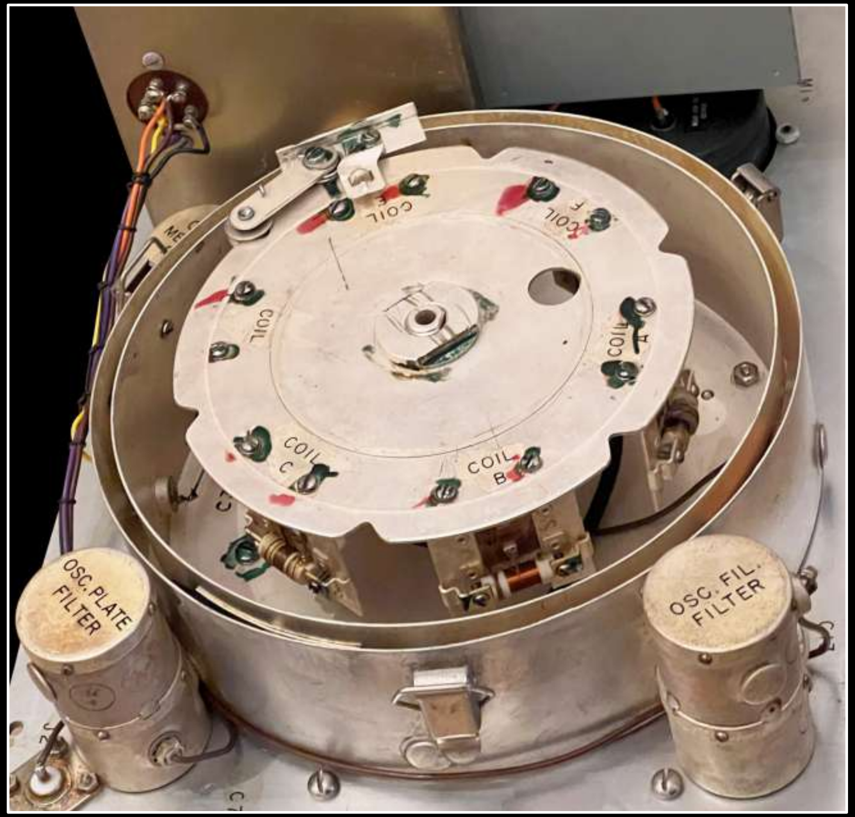
1950

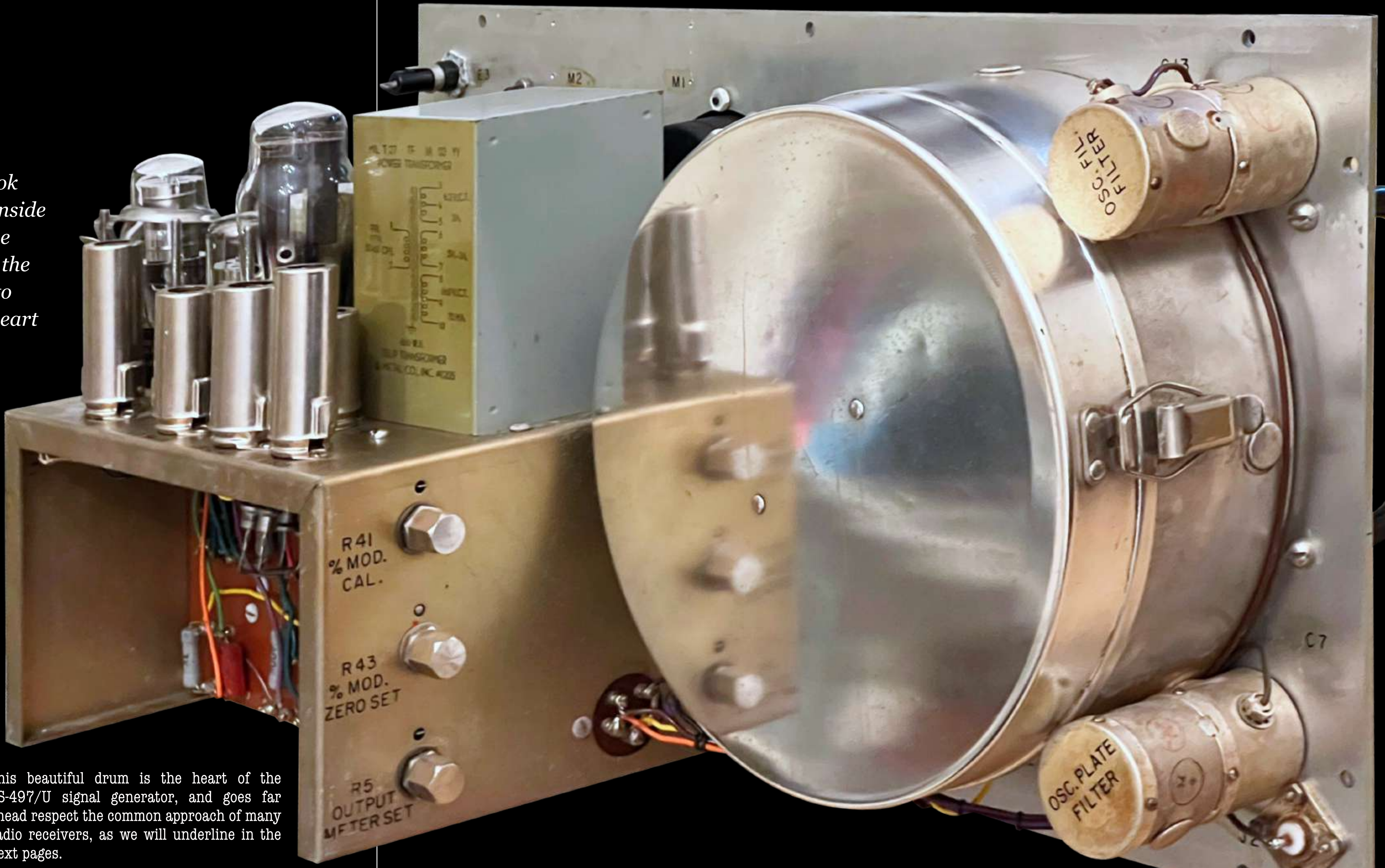
THE MYSTERY OF THE NAME - Maybe that I lost something, but in my opinion the name TS-497/URR has something strange. According the Army/Navy nomenclature, "/URR" stays for Utility, Radio, Receiver. By the way, all the other instruments (TS-397, 505, 585 etc.) have only the "/U" suffix.


CAUTION
BEFORE OPERATION REVIEW
TM11-5030A PACKED WITH EQUIPMENT
SIGNAL CORPS U.S. ARMY
SIGNAL GENERATOR TS-497B/URR
MUNSTON MFG. & SERVICE, INC. ISLIP, N.Y.
B
MEGACYCLES
OUTPUT
PERCENT MODULATION
FUSE
SPARE
EXT. PULS
PERCENT MOD.
PAD
MICROVOLTS
CARRIER OUTPUT
EXT OFF 400 1000
POWER
ON
OFF
EXT. MOD

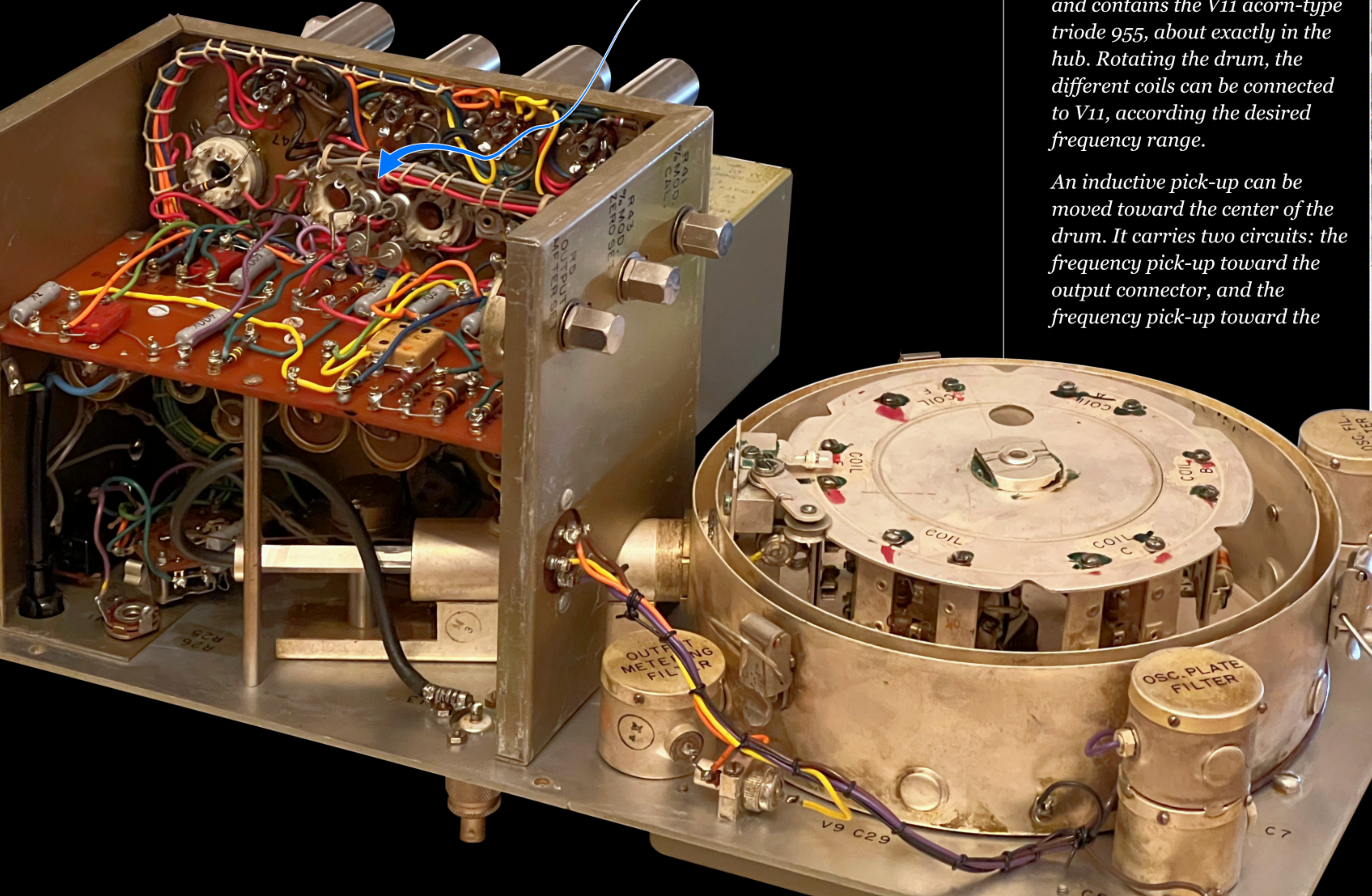
Silver cookware

When you open the TS-497/URR, you first idea is: what can I cook with it? As a matter of fact, the appearance of the right module inside it is that of a beautiful, silver-plated pot... but it is the coffer of the electronic treasures, on which the TS is based. Removing the lid, the look does not change too much: a second lid still forbids the eye to investigate the TS's secrets. The second lid removed, here is the heart of this instrument.


COIL
COIL F
COIL A
COIL
COIL C
COIL B
OSC. PLATE FILTER
OSC. FIL. FILTER


M2
M1
OSC. FIL. FILTER
R41 % MOD. CAL.
R43 % MOD. ZERO SET
R5 OUTPUT METER SET
C7
OSC. PLATE FILTER

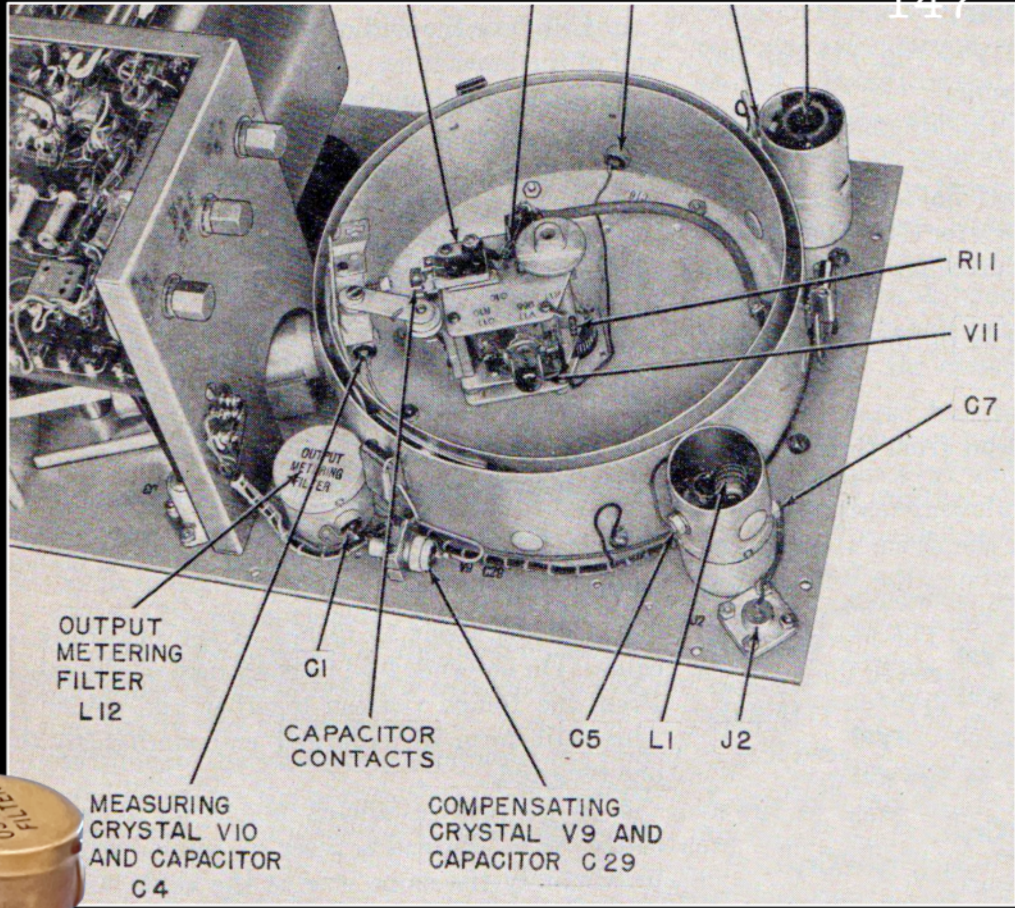
This beautiful drum is the heart of the TS-497/U signal generator, and goes far ahead respect the common approach of many radio receivers, as we will underline in the next pages.


COIL F
COIL A
COIL B
COIL C
COIL
COIL
OSC. PLATE FILTER
OUTPUT METERING FILTER
OSC. FIL. FILTER
V9 C29
C7
R5 OUTPUT METER
R43 % MOD ZERO SET
R43 % MOD CAL
R25
R26

Here you can see four diodes that someone installed to replace the rectifier tube.

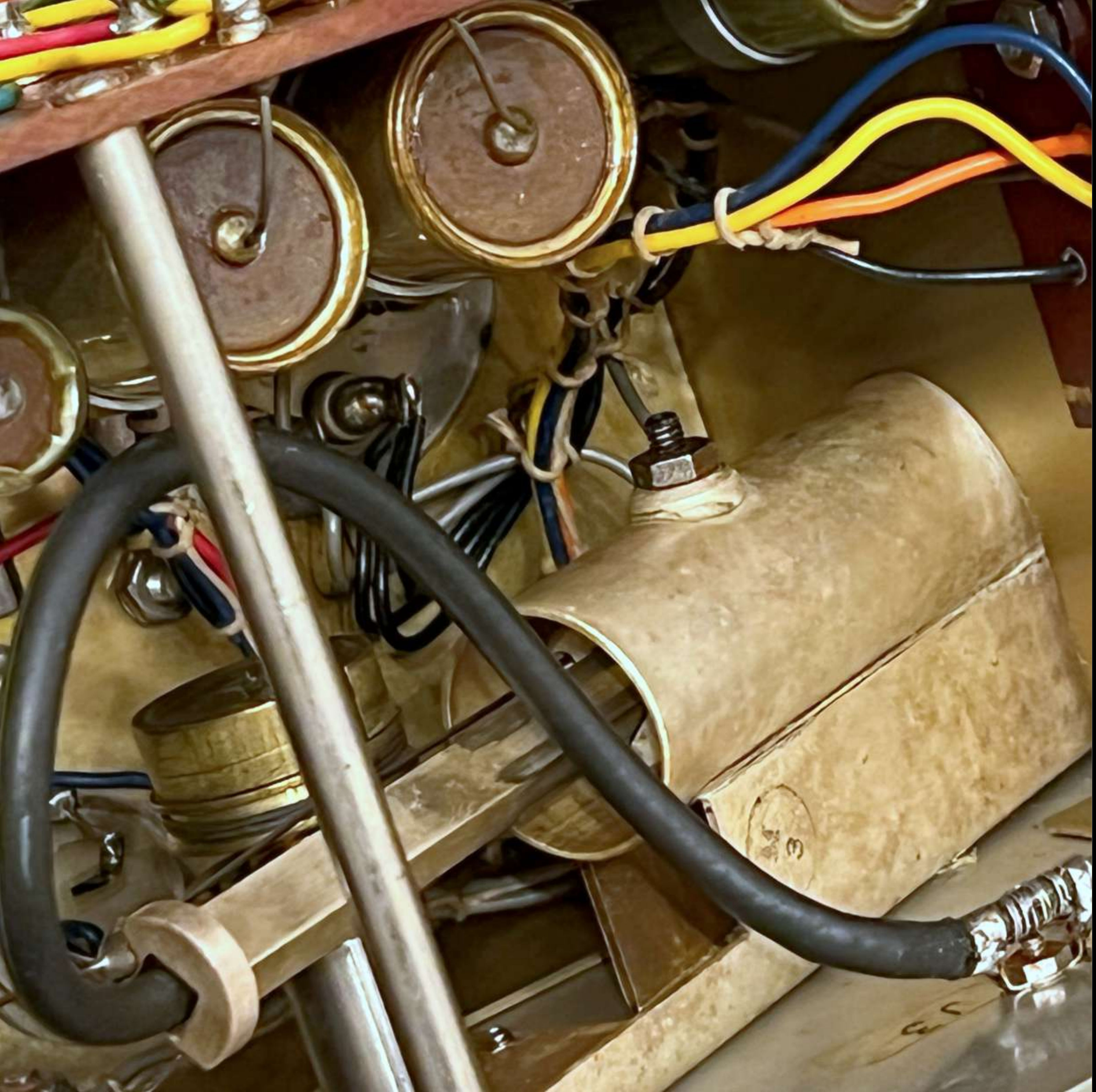
The drum is the master oscillator and contains the V11 acorn-type triode 955, about exactly in the hub. Rotating the drum, the different coils can be connected to V11, according the desired frequency range.

An inductive pick-up can be moved toward the center of the drum. It carries two circuits: the frequency pick-up toward the output connector, and the frequency pick-up toward the internal electronic voltmeter, that allows to read the amplitude of the output signal itself.


R11
V11
C7
OUTPUT METERING FILTER L12
C1
CAPACITOR CONTACTS
C5
L1
J2
MEASURING CRYSTAL V10 AND CAPACITOR C4
COMPENSATING CRYSTAL V9 AND CAPACITOR C29

Very interesting the presence of two "crystal diodes". The TS-497 started using semiconductors, very early for a 1950 equipment. Note the double shield and the smaller cylinders for the filters toward the master oscillator.

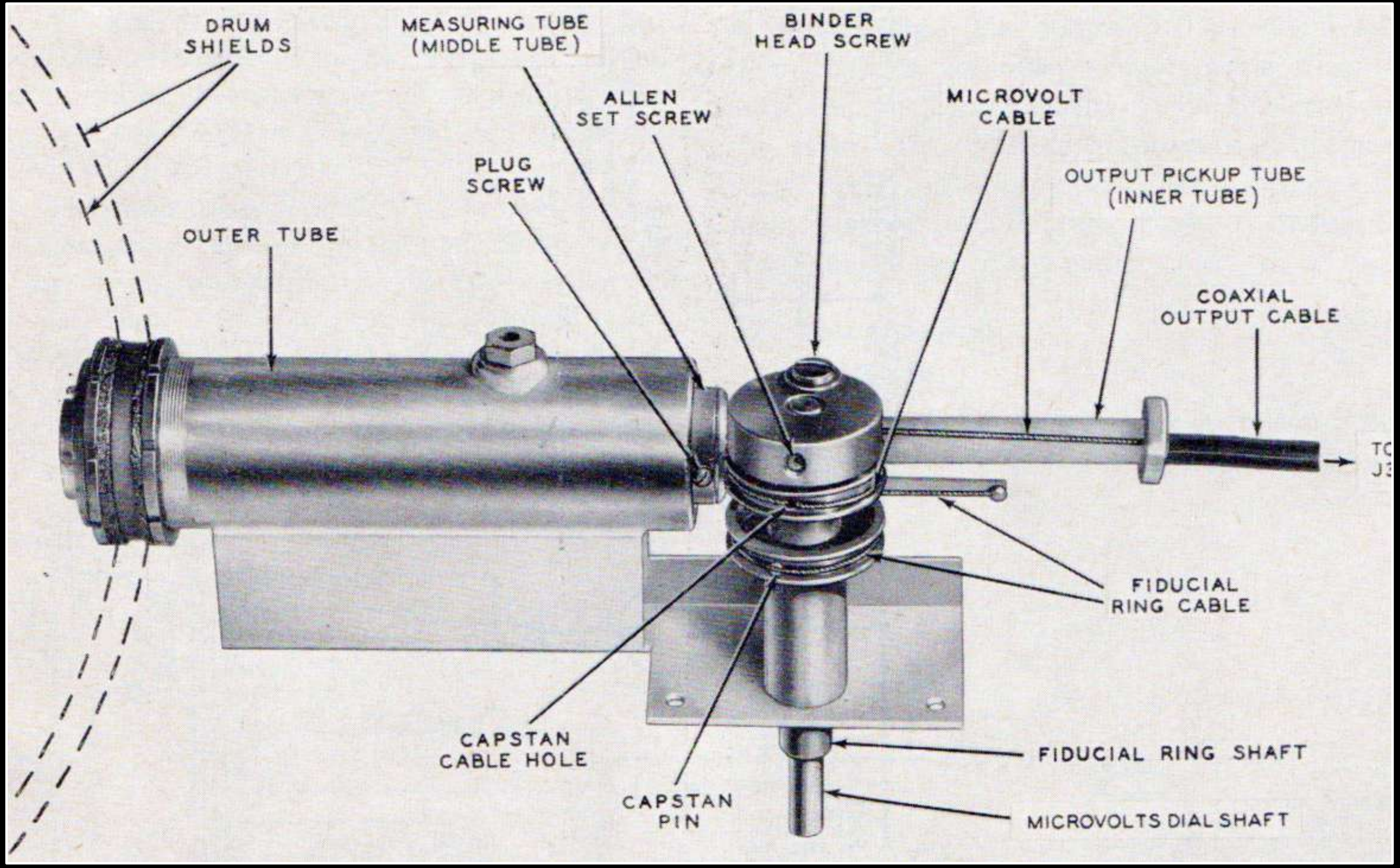
The hub includes the variable capacitor used to vary the oscillation frequency.



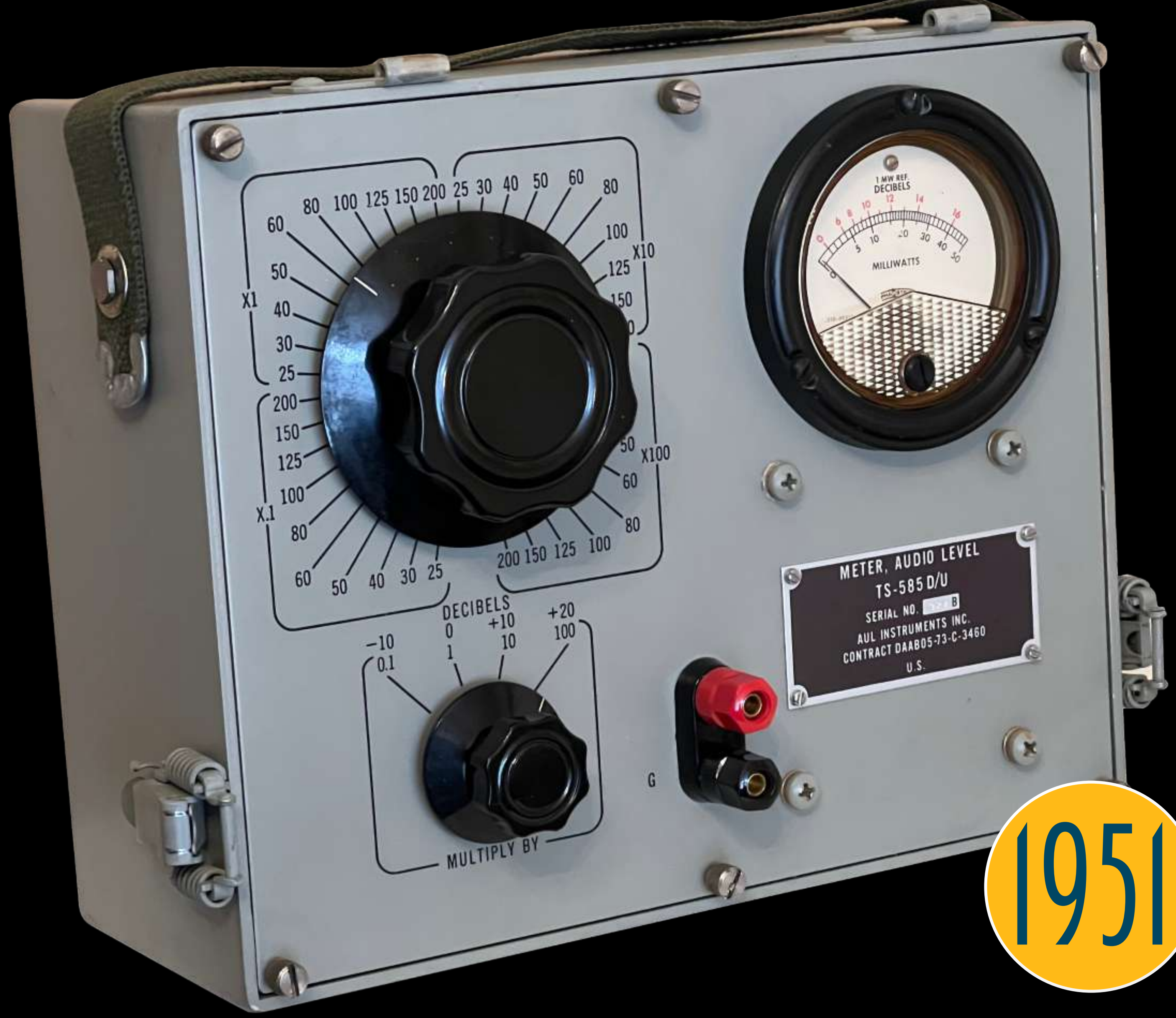
Also the output attenuator used to couple the oscillator output to the CARRIER OUTPUT connector is very interesting. It uses a piston that varies the mutual inductance between two coils and the oscillator coil

The piston consists of three concentric metal tubes and a length of coaxial wire. It serves as a guide within which the other tubes are free to move axially. The middle tube carries the measuring pickup loop and measuring crystal rectifierV10.

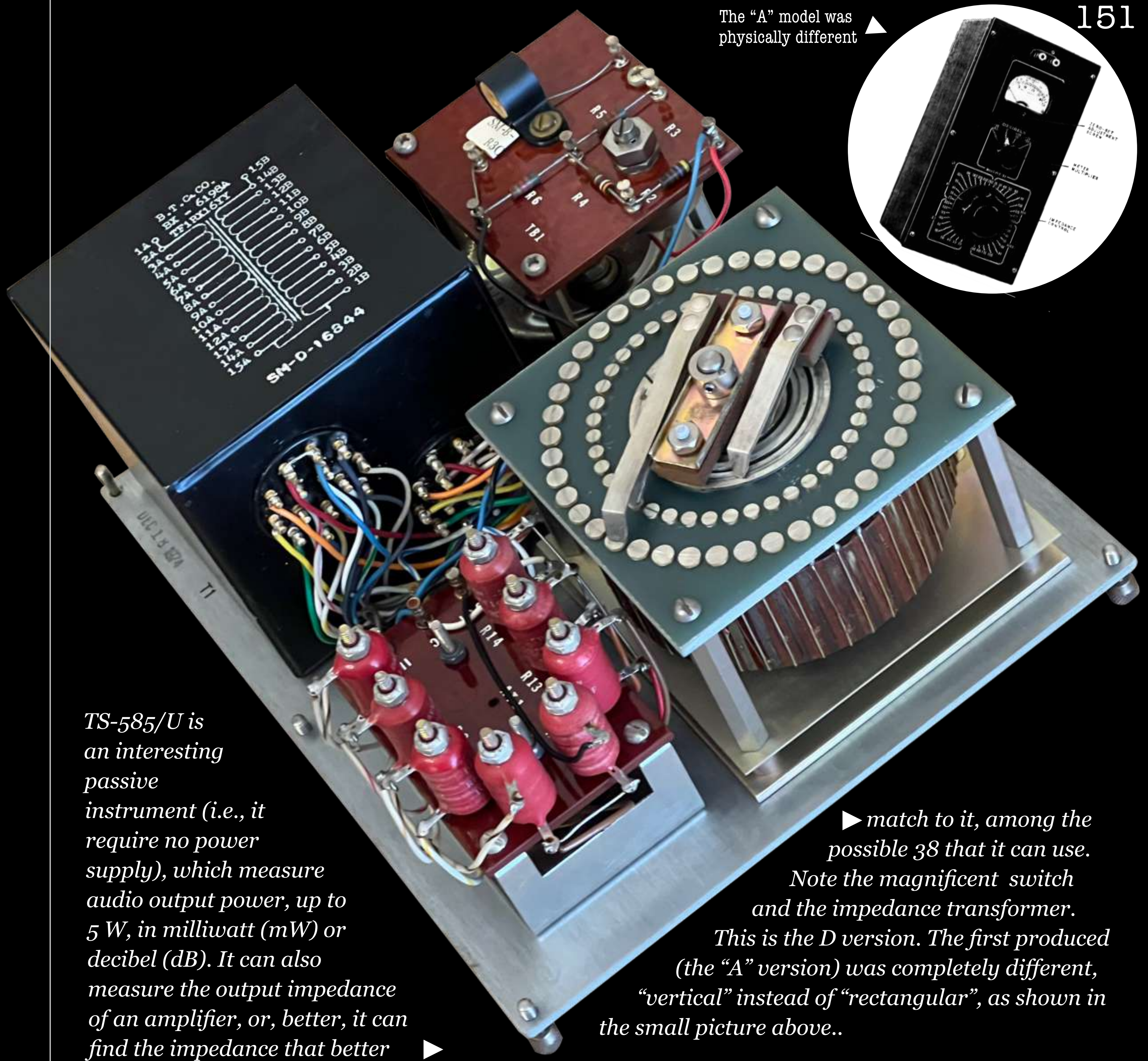
The middle tube is driven by the fiducial ring through a mechanical linkage. The inner tube carries the output pickup loop to which is connected the coaxial cable that runs through the center of the inner tube and to CARRIER OUTPUT connector. The inner tube driven by the MICROVOLTS dial through a mechanical linkage (special wire cable). Both pickup loops are in the field of the oscillator tank coil.


DRUM SHIELDS
MEASURING TUBE (MIDDLE TUBE)
BINDER HEAD SCREW
ALLEN SET SCREW
MICROVOLT CABLE
PLUG SCREW
OUTPUT PICKUP TUBE (INNER TUBE)
OUTER TUBE
COAXIAL OUTPUT CABLE
TO J3
FIDUCIAL RING CABLE
CAPSTAN CABLE HOLE
FIDUCIAL RING SHAFT
CAPSTAN PIN
MICROVOLTS DIAL SHAFT

TS-585/U
How loud?


1 MW REF
DECIBELS
MILLIWATTS
X1
X10
X100
DECIBELS
MULTIPLY BY
G
METER, AUDIO LEVEL
TS-585 D/U
SERIAL NO.
AUL INSTRUMENTS INC.
CONTRACT DAAB05-73-C-3460
U.S.

1951


SM-D-168844
R5
R3
R6
R4
TB1
R14
R13
T1

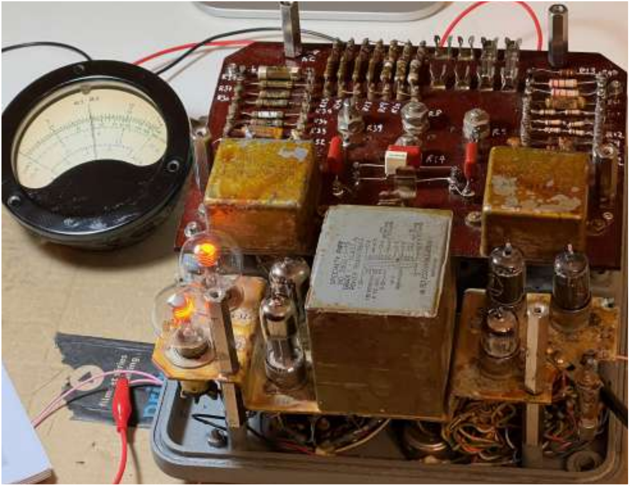
The “A” model was physically different ▶

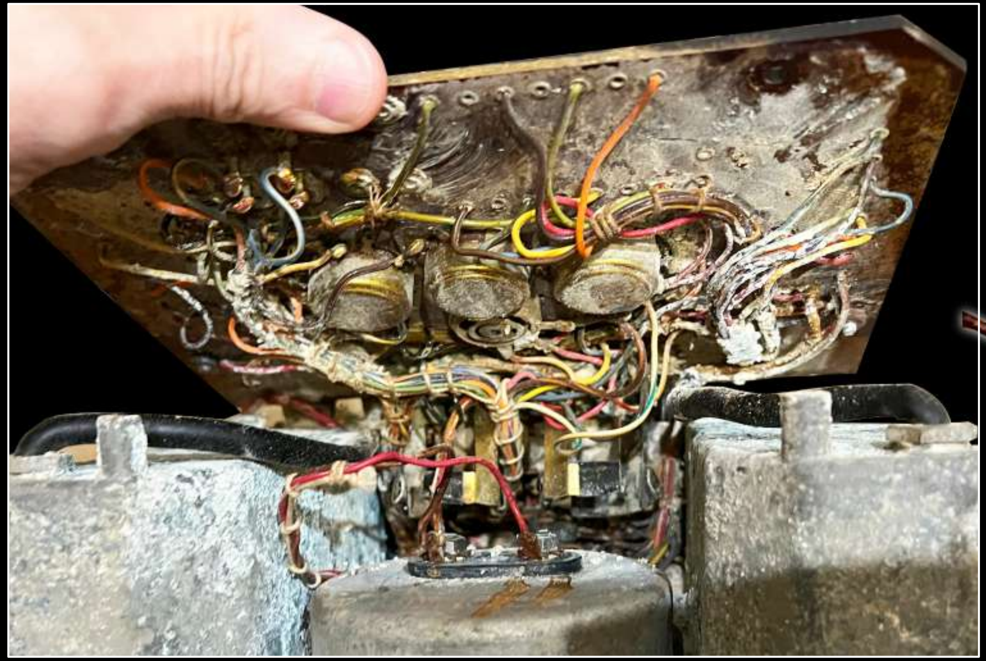
TS-585/U is an interesting passive instrument (i.e., it require no power supply), which measure audio output power, up to 5 W, in milliwatt (mW) or decibel (dB). It can also measure the output impedance of an amplifier, or, better, it can find the impedance that better ▶

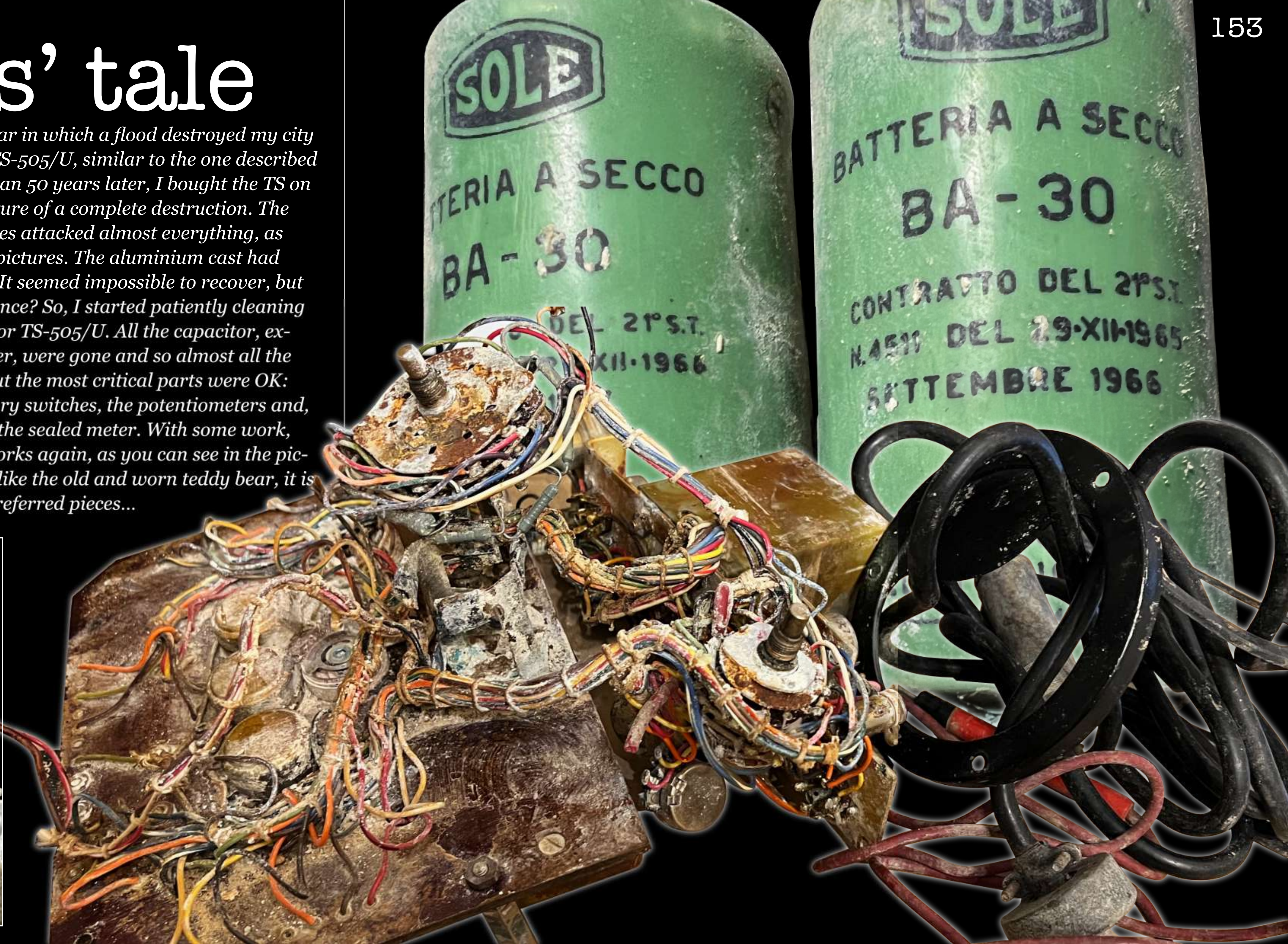
▶ *match to it, among the possible 38 that it can use. Note the magnificent switch and the impedance transformer. This is the D version. The first produced (the “A” version) was completely different, “vertical” instead of “rectangular”, as shown in the small picture above..*

Two batteries' tale

They were produced in the "Sole" (sun) factory Italy in 1966, the year in which a flood destroyed my city of Florence. They were probably installed in those years in a 1951 TS-505/U, similar to the one described on page 131, and remained there until few days ago, when, more than 50 years later, I bought the TS on eBay and opened the batteries compartment. Wow! I found the picture of a complete destruction. The acid from the batteries attacked almost everything, as you can see in these pictures. The aluminium cast had even been corroded. It seemed impossible to recover, but why not give it a chance? So, I started patiently cleaning and checking this poor TS-505/U. All the capacitor, except the two big paper, were gone and so almost all the precision resistor. But the most critical parts were OK: the silver plated rotary switches, the potentiometers and, the most important, the sealed meter. With some work, eventually, it now works again, as you can see in the picture on the left! And like the old and worn teddy bear, it is now one of the my preferred pieces...






SOLE
TTERIA A SECCO
BA - 30
DEL 21°S.T.
XII-1966
SOLE
BATTERIA A SECCO
BA - 30
CONTRATTO DEL 21°S.T.
N.4511 DEL 29-XII-1965
SETTEMBRE 1966

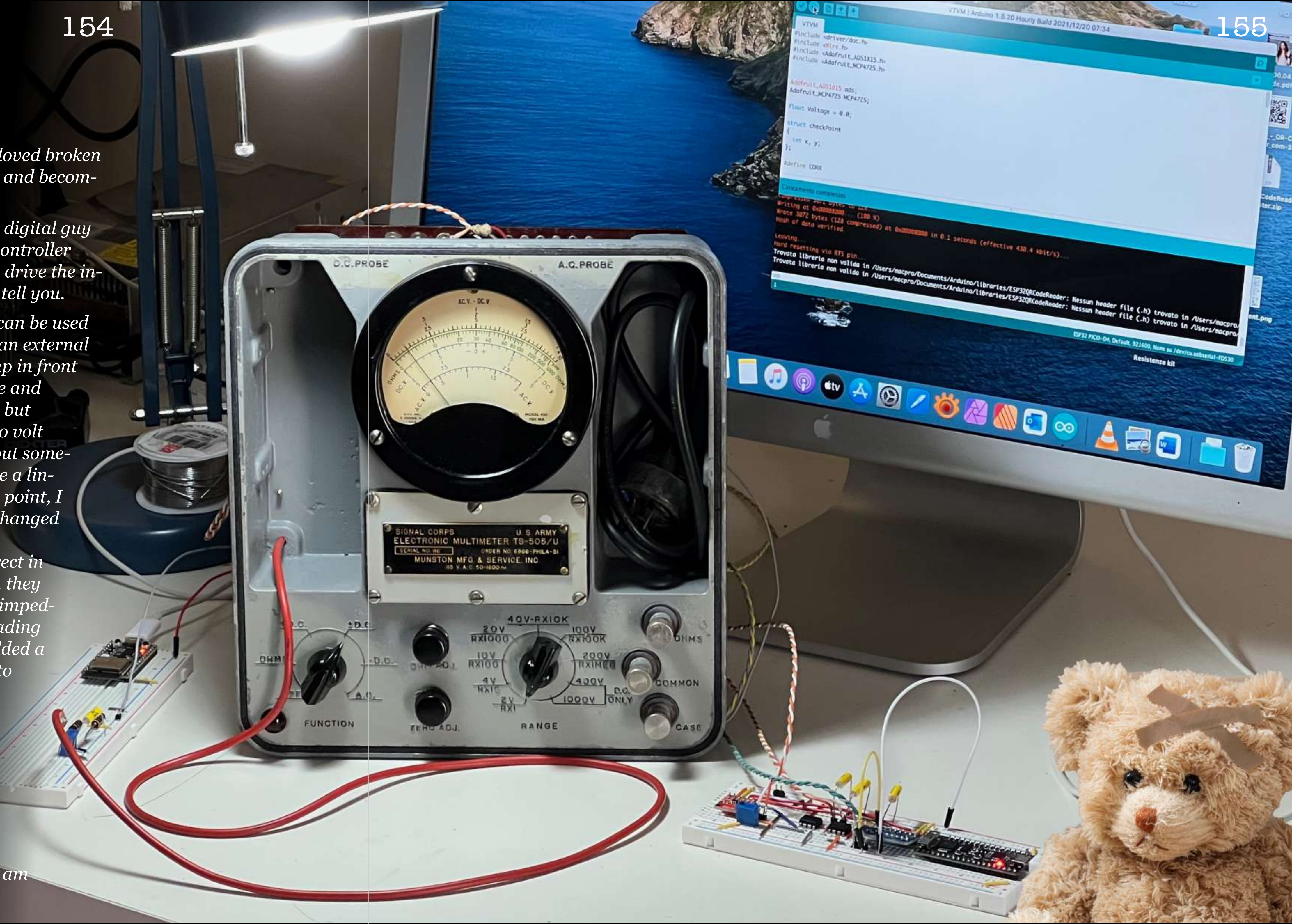
The end of the Teddy Bear

On the previous page, I likened the 1951 TS-505/U to the old and beloved broken Teddy Bear. He didn't survive long: its transformer started leaking and becoming hot, and one of the gas discharge tubes stopped working.

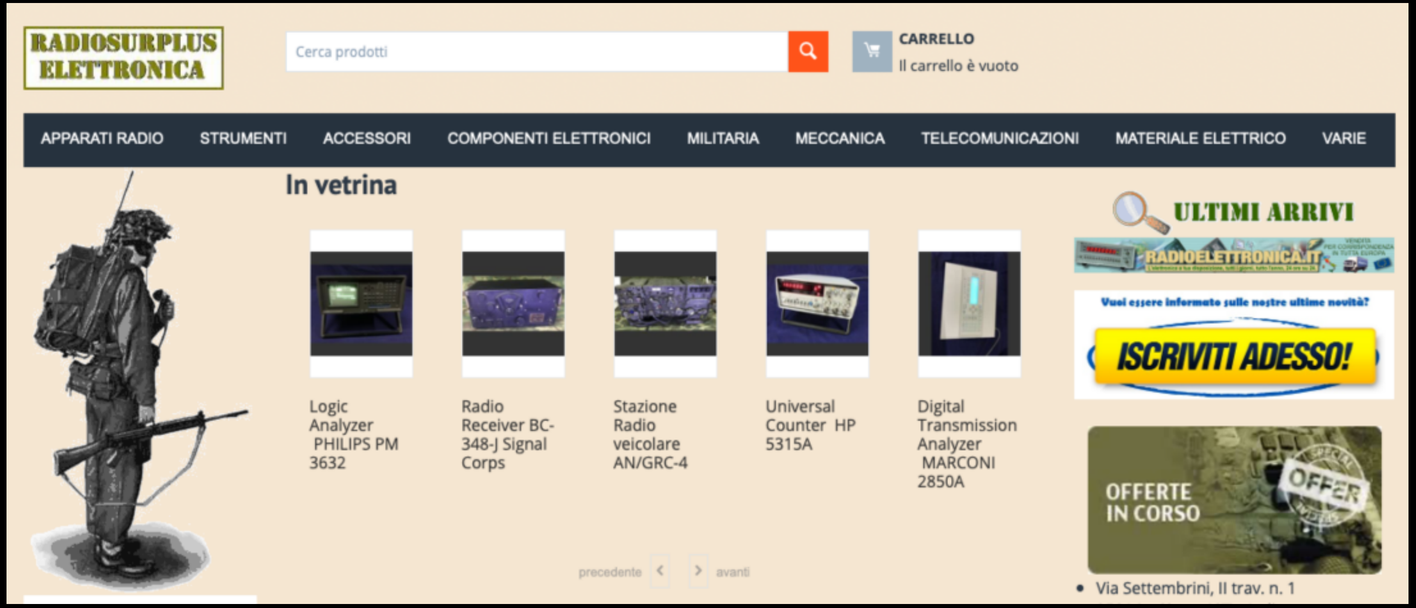
I was tempted to modify that old stuff with the weapons that an old digital guy could have... so I replaced the tube electronic with a modern microcontroller (ESP32). I could use an ADC to read the input voltage and a DAC to drive the instrument, I though, as easy as... But things are never easy, as I will tell you.

First of all, the ADC channel of the Espressif ESP32 is not linear: it can be used for simple applications but not for a real measurement. So I added an external Analog Devices ADS1105, 15 bit + sign AD converter. with an op amp in front of it, to have high input impedance. Wonderful: it is very easy to use and very precise. Then I tried to drive the beautiful meter with the DAC, but again, the DAC of the ESP32 is almost a toy: it cannot reach the zero volt lower limit, So I added a MCP4725, 12 bit DAC. Again, wonderful, but something was still not OK. The meter is itself not linear, so I had to write a linearisation function to make its indication absolutely precise. At this point, I connected the new board to the old voltage divider of the TS, after changed all the resistors to new ones (the old were open), and ...surprise. Everything was OK in the lowest scale, but the values were not correct in the other settings. Wrong resistors value in the voltage divider? No, they were OK, but the point was ***the noise****: working on 20Mohm input impedance, the noise from the microcontroller was enough to alter the reading (besides some imprecision by design in the resistors values). So I added a second op amp, taking advantage of the possibility of the ADS1105 to work on differential inputs, to cancel the common mode noise. An improvement but not the victory. At the end, I decided to use with a trick the second section of the range switch, to read its position. In this way I could develop specific linearisation functions for each range, arriving eventually to the final result of an indeed good precision. Things are never so easy as they seem, and praise to the original designers, who could do without any software help!*

But now the fun is over and I am trying to restore its original tube operation. I found a Chinese transformer but not the gas tubes, so I am trying to replace them with two zener diodes (to be continued).



Surplus suppliers


RADIOSURPLUS ELETTRONICA
Cerca prodotti
CARRELLO
Il carrello è vuoto
APPARATI RADIO
STRUMENTI
ACCESSORI
COMPONENTI ELETTRONICI
MILITARIA
MECCANICA
TELECOMUNICAZIONI
MATERIALE ELETTRICO
VARIE
ULTIMI ARRIVI
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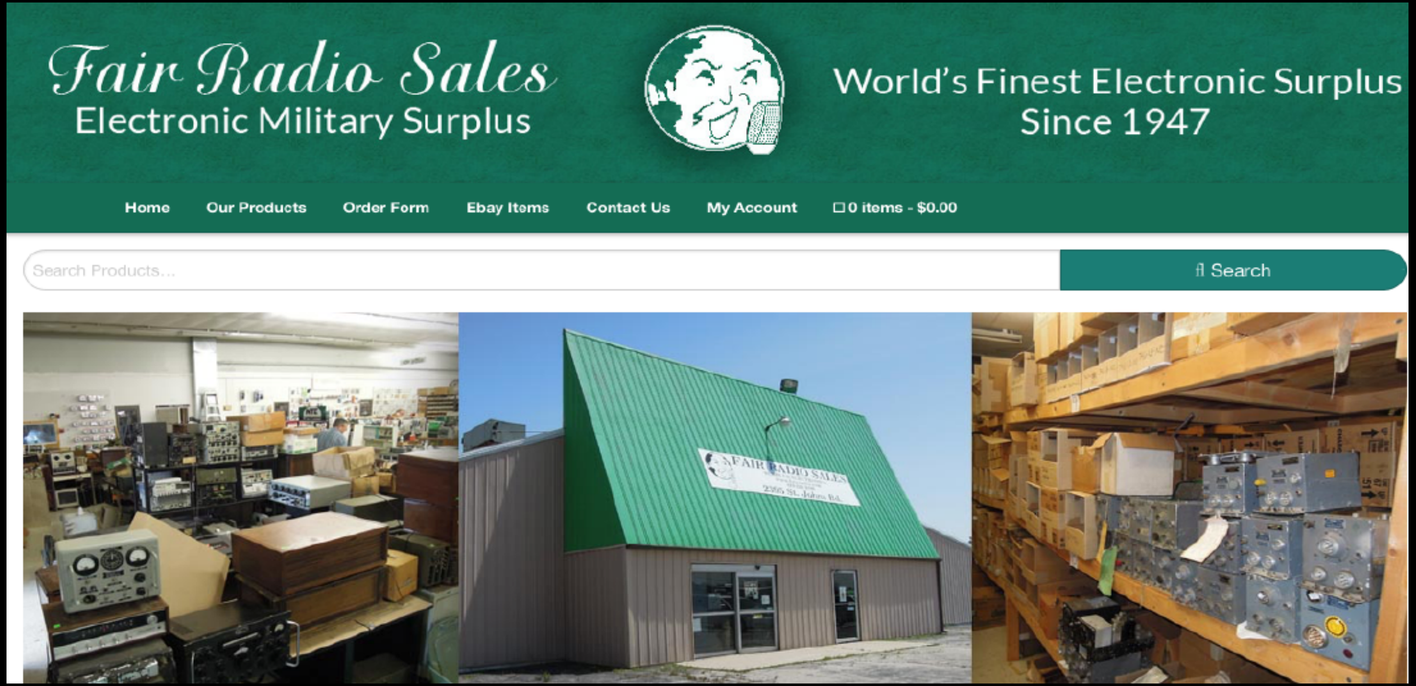
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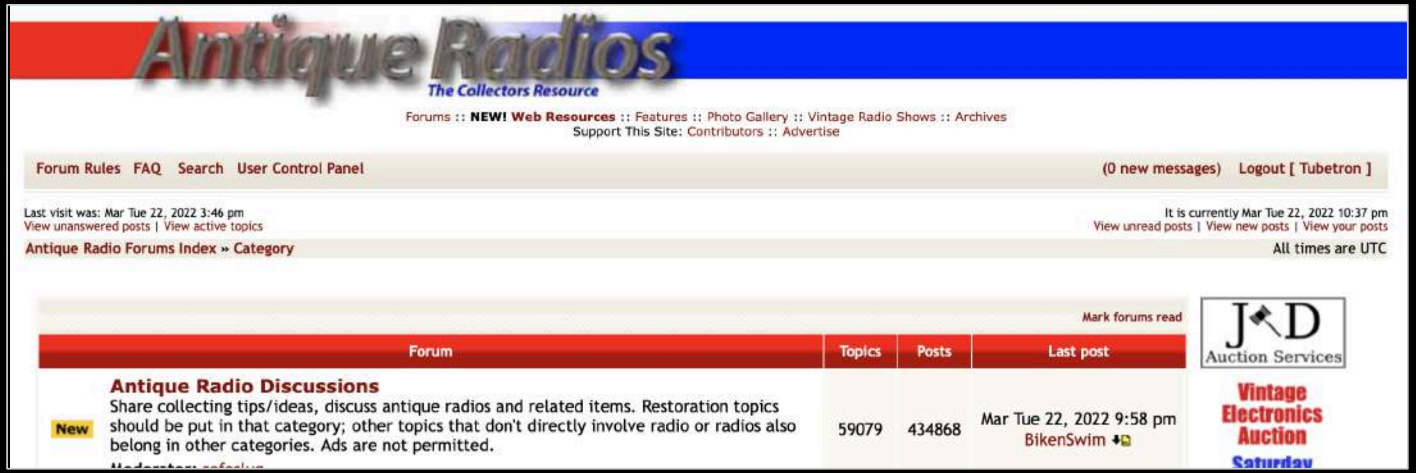
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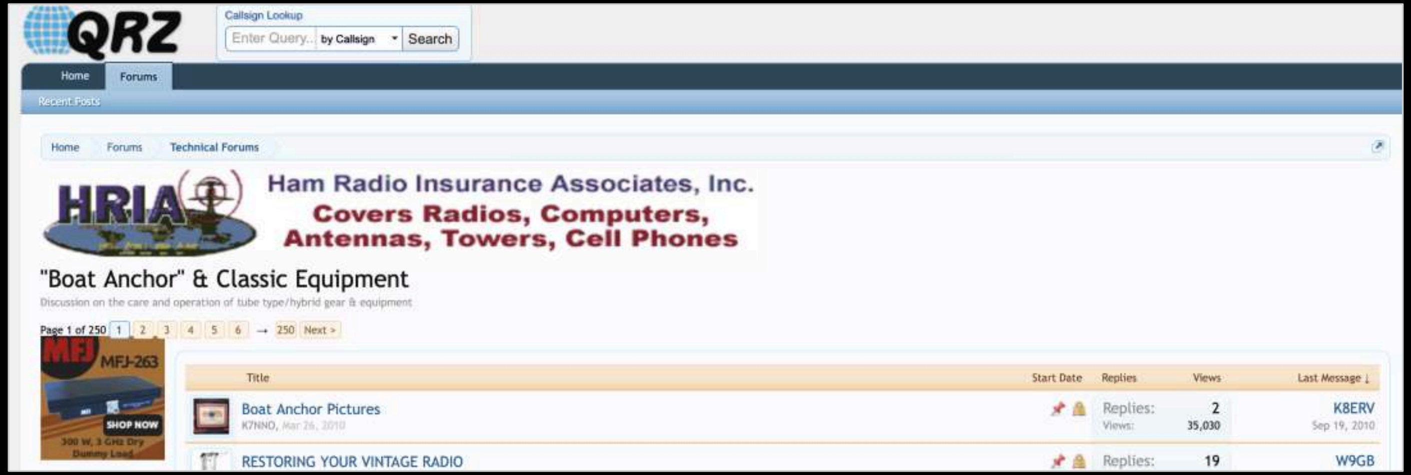
	Forum	Topics	Posts	Last post
New	**Antique Radio Discussions** Share collecting tips/ideas, discuss antique radios and related items. Restoration topics should be put in that category; other topics that don't directly involve radio or radios also belong in other categories. Ads are not permitted.	59079	434868	Mar Tue 22, 2022 9:58 pm BikenSwim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"Boat Anchor" & Classic Equipment

Discussion on the care and operation of tube type/hybrid gear & equipment

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RESTORING YOUR VINTAGE RADIO		Replies: 19		W9GB

About me

About me

My name is Giovanni Becattini (but everybody calls me Gianni) and live in Florence, Italy. I started working in professional electronics more than 50 years ago and I spent my life in electronic industry.

All the photos here have been taken with a normal iPhone (8S and then 13 Pro) and edited with Affinity Photo. This document has been created with Affinity Publisher.

giovanni.becattini@aep-italia.it

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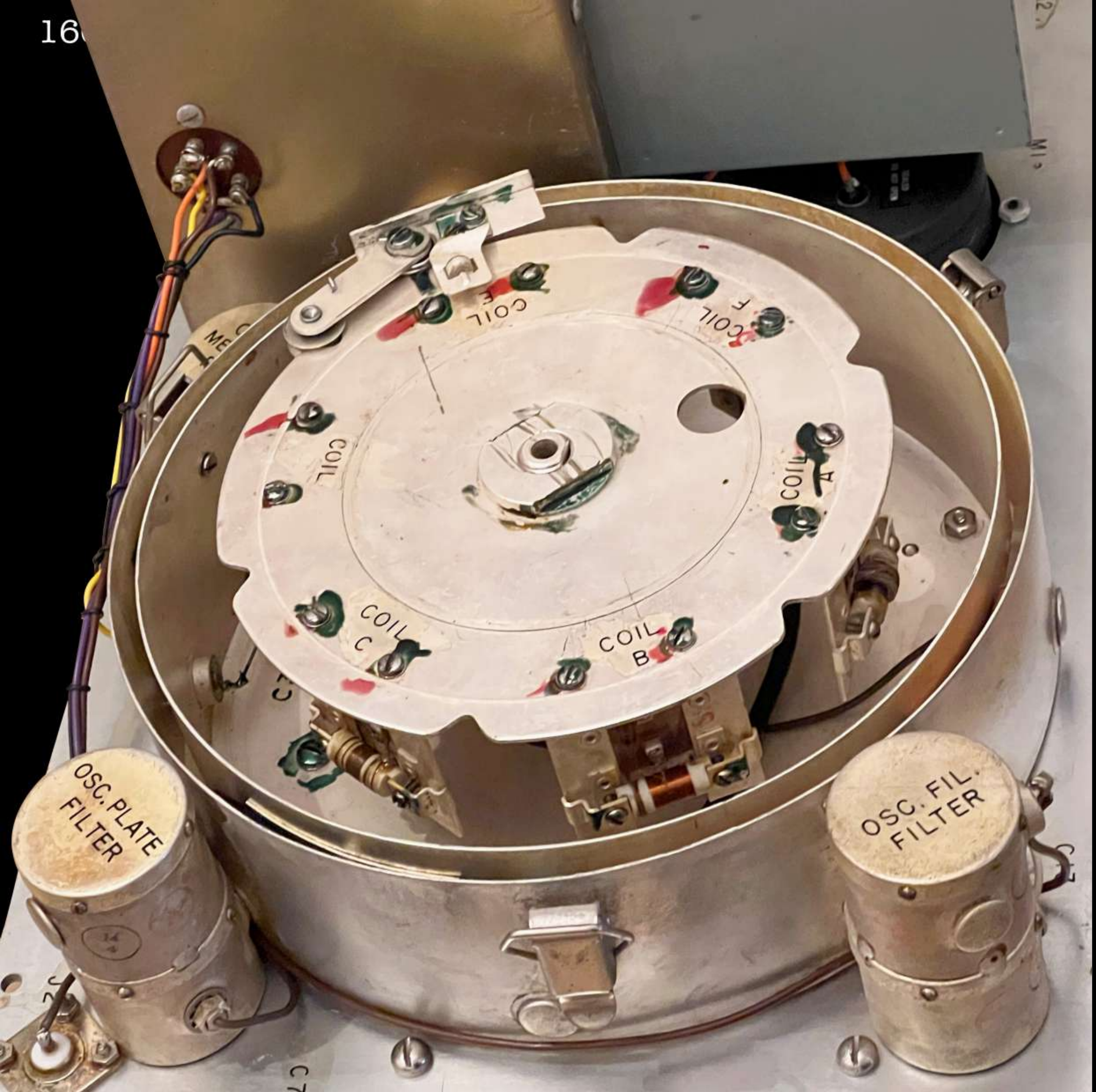
G. Becattini



Revision history

Rel.	Date	Notes
1.0	March 29	First edition (2022)
2.0	April 1	GRC-7 text revised and 6 pages added.
3.0	April 5	Removed a duplicated para on page 49. Added the page “Instruments”. Slightly modified the text for TV-7 tube tester. Added a couple of pages about ZM-3/U. Slightly modified the text about ZM-11/U. Added two pages on TS-585/U. Added 4 pages on R-648 and R-727. Added two pages on Siemens E311 receiver. Added two pages on Allocchio Bacchini AC-18 receiver. Added two pages on G133F.
4.0	April 6	Added two pages on R-44 and R-45.
5.0	May 1	Added two pages “Two batteries tale”. Three couple of pages added to Siemens E309. A couple of pages added for ARC-2/RT-91. Added a link to www.radiomilitari.com. Small correction in the text for 51J receiver. A couple of pages added for the table of content. Added a couple of pages about ART-13. Added many labels with the year. Reordered pages to some chronological sort. Added timeline. Added two pages about Racal RA.17 dimensions. Two pages added on BC-348. Two pages added on R-107.
6.0	July 7	Added two pages “The end of the Teddy Bear” - Four couples of pages added for Siemens E311 - Added 28 pages for the new Tektronix session.
7.0		Tektronix section completely rewritten - Added Tektronix suppliers and forum.
8.0	August 1	Added 4 pages technical note on 7603 power supply repair. Added the general wiring diagram. Added two page on internal connections. Added two pages on key labels.
9.0	Sept. 15, 2022	The Tektronix section has been removed. The description of the BC-221 frequency meter has been extended. Two new devices has been added: the TS-375/U electronic voltmeter and the TS-497/URR signal generator.

V6
5AX5
V4
6CB6
5651
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